277-T OUTDOOR STORAGE AREA
ADDENDUM H
CLOSURE PLAN

CHANGE CONTROL LOG

Change Control Logs ensure that changes to this unit are performed in a methodical, controlled, coordinated, and transparent manner. Each unit addendum will have its own change control log with a modification history table. The "**Modification Number**" represents Ecology's method for tracking the different versions of the permit. This log will serve as an up to date record of modifications and version history of the unit.

Modification History Table

Modification Date	Modification Number
12/06/2021	8C.2021.1F

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TERMS

ASTM	American Society for Testing and Materials
CAA	Central Accumulation Area
CFR	Code of Federal Regulations
COC	Chain-of-Custody
CPCCo	Central Plateau Cleanup Company, LLC
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy, Richland Operations Office
DQA	Data Quality Assessment
DQO	Data Quality Objectives
DWMU	Dangerous Waste Management Unit
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FWS	Field Work Supervisor
HEIS	Hanford Environmental Information System
HHE	Human Health and the Environment
HMWA	Hazardous Waste Management Act (RCW 70A.300, WAC 173-303)
IQRPE	Independent Qualified Registered Professional Engineer
MTCA	Model Toxics Control Act—Cleanup (RCW 70A.305, WAC 173-340)
PQL	Practical Quantitation Limit
QA	Quality Assurance
QC	Quality Control
RCRA	*Resource Conservation and Recovery Act of 1976*
RCW	Revised Code of Washington
SAA	Satellite Accumulation Area
SAP	Sampling and Analysis Plan
SWOC	Solid Waste Operations Complex
VOA	Volatile Organic Analysis
VSP	Visual Sample Plan
WAC	Washington Administrative Code
WIDS	Waste Information Data System

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H.1 Introduction

The purpose of this plan is to describe the *Resource Conservation and Recovery Act of 1976* (RCRA)/Hazardous Waste Management Act (HWMA), Chapter 70A.300 Revised Code of Washington (RCW) closure process for the 277-T Outdoor Storage Area Dangerous Waste Management Unit (DWMU), hereinafter called the 277-T Outdoor Storage Area. The 277-T Outdoor Storage Area is located in the northeast portion of the T Plant Complex in the 200 West Area of the Hanford Site (Figure H-1). The U.S. Department of Energy (DOE) and Central Plateau Cleanup Company, LLC (CPCCo), hereinafter called the Permittees, have agreed with the U.S. Environmental Protection Agency (EPA) and Washington State Department of Ecology (Ecology) through a Consent Agreement and Final Order (EPA Docket No. RCRA-10-2013-0113) to close this DWMU. The 277-T Outdoor Storage Area is no longer used for storage of dangerous or mixed waste and will be clean closed.

This closure plan complies with closure requirements in Washington Administrative Code (WAC) 173-303-610(2) through WAC 173-303-610(6), *Closure and post-closure,* and WAC 173-303-630(10), *Use and management of containers*.

Amendments to this closure plan must be submitted as a permit modification request in accordance with Permit Condition I.C.3.

Minor deviations from this closure plan must be addressed in accordance with Permit Condition II.K.6.

Closure requirements are based on RCW 70A.300, WAC 173-303, and Ecology guidance (Ecology Publication #94-111, *Guidance for Clean Closure of Dangerous Waste Units and Facilities*). This closure plan is also designed to fulfill the elements of the Data Quality Objectives (DQO) Process, as defined in EPA Publication EPA/240/B-06/001, *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA QA/G-4). A site-specific DQO has been incorporated into this closure plan.

This closure plan describes in detail the closure activities necessary to achieve closure performance standards for the 277-T Outdoor Storage Area. Closure activities include:

- Removal of all dangerous and mixed waste.
- Records review (i.e., container storage, operating, and inspection records) for documented spills or releases of dangerous or mixed waste and subsequent cleanup activities.
- Visual inspection to evaluate the condition of the concrete and asphalt surfaces and the likelihood of potential exposure pathways for contamination of the underlying soil.
- Decontamination of the concrete surfaces using an Ecology-approved decontamination method.
- Chip sampling of concrete pads to evaluate whether decontamination was successful and closure performance standards are met.
- Sampling of underlying soil to evaluate whether closure performance standards are met.
- Transmit closure certification to Ecology.

Closure will be performed in accordance with the schedule provided in Section H.6.

Figure H-1 T Plant Complex Overview, 277-T Outdoor Storage Area Dangerous Waste Management Unit (Month Unknown, 2017)

H.1.1 Unit Description

The 277-T Outdoor Storage Area (Figure H-2) is located west of the 221-T Canyon Building, north of the 221-T Railroad Tunnel, and surrounding the 277-T Building. The 277-T Building is shown but is not included in the 277-T Outdoor Storage Area DWMU. The 277-T Outdoor Storage Area was previously used for storing containers of various sizes and volumes, and a variety of waste streams to ensure adequate capacity and operational flexibility to support T Plant activities. The 277-T Outdoor Storage Area consists of two uncoated concrete pads and an asphalt area surrounding the 277-T Building.

The 277-T Outdoor Storage Area is 29 m (95 ft) on the south side by 26 m (86 ft) on the west side by 41 m (135 ft) on the north side by 23 m (76 ft) on the east side. Figure H-3 shows the concrete pad located behind the 277-T Building. Figure H-4 shows the concrete pad located in front of the 277-T Building. Aside from the concrete pads in front of and behind the 277-T Building, the remainder of the 277-T Outdoor Storage Area is asphalt. Figure H-5 shows a blow-down line and gravel drain on the northeast side of 277-T Building. The blow-down line carried steam condensate from the 277-T Building steam heating system and discharged the condensate at the gravel drain. The drain terminates to soil. The condensate lines are no longer in service and significant portions have been removed from the 277-T Building.

The 277-T Outdoor Storage Area may have been used to manage dangerous and mixed waste in a Central Accumulation Area (CAA) or Satellite Accumulation Area (SAA). The 277-T Outdoor Storage Area does not currently store dangerous and mixed waste. Future storage of dangerous and mixed waste is not authorized within the 277-T Outdoor Storage Area DWMU.

Figure H-2 277-T Outdoor Storage Area (looking southeast) (May 2017)

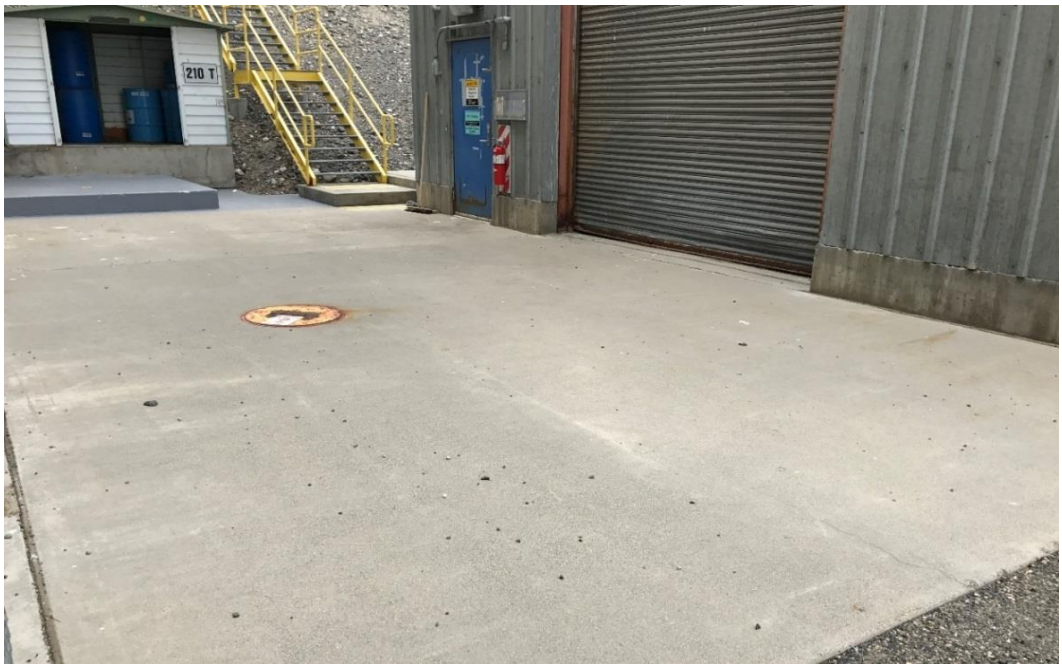

Figure H-3 277-T Outdoor Storage Area Behind the 277-T Building (looking west southwest) (May 2017)

Figure H-4 277-T Outdoor Storage Area in Front of the 277-T Building (looking south-southeast) (May 2017)

Figure H-5 277-T Outdoor Storage Area Blow Down Drain on Side of 277-T Building (Middle of building, northeast side) (May 2017)

H.1.2 Maximum Waste Inventory

No dangerous waste permitted storage was identified during the T Plant operating records review (Section H.3.2); therefore, no maximum waste inventory is presented. Weekly waste management area inspection records identified that the 277-T Outdoor Storage Area may have managed dangerous and mixed waste.

H.1.3 Personnel Safety and Training Requirements

Closure will be performed in a manner to ensure the safety of Human Health and the Environment (HHE). Health and safety requirements are addressed in Section H.1.3.1, and training for facility and closure personnel is described in Section H.1.3.2.

H.1.3.1 Health and Safety Requirements

Personnel will be trained in the applicable safety and environmental procedures described in Table H-1. Personnel will be equipped with appropriate personal protective equipment. Personnel will perform all field operations and any necessary closure activities in compliance with applicable health, safety, and environmental procedures and requirements.

Pre-job briefings will be performed to evaluate activities and associated hazards by considering the following factors:

- Objective of the activities.
- Individual tasks to be performed.
- Hazards associated with the planned tasks.

- Environment in which the job will be performed.
- Facility where the job will be performed.
- Equipment and material required.
- Safety protocols applicable to the job.
- Training requirements for individuals assigned to perform the work.
- Level of management control.
- Proximity of emergency contacts.

H.1.3.2 Training Requirements

The Permittees have instituted training and qualification programs to meet training requirements imposed by regulations, DOE orders, and national standards such as those published by the American National Standards Institute/American Society of Mechanical Engineers. For example, the environmental, safety, and health training program provides workers with the knowledge and skills necessary to execute assigned duties safely. Permit Attachment 5, *Hanford Facility Personnel Training Program*, describes specific requirements for the Hanford Facility Personnel Training Program. The Permittees will comply with the training matrix shown in Table H-1, which provides training requirements for Hanford Facility personnel associated with the 277-T Outdoor Storage Area.

Project-specific safety training will provide the knowledge and skills that personnel need to perform work safely and in accordance with Quality Assurance (QA) requirements. Training records are maintained for each employee in an electronic training record database. The Permittee's training organization maintains the training records system.

Table H-1 Training Matrix for the 277-T Outdoor Storage Area Dangerous Waste Management Unit

Training Category Course Description[a]	Frequency of Training	Training Type[b]	Job Title/Position					
			Non-T Plant Personnel or Visitor	FWS	SPOC	ECO	BED	FS
General Training	Annual	GHFT, CPT	X	X	X	X	X	X
Building Emergency	Annual	ECT					X	
ECO Training	Initial	OT				X		
Facility Health and Safety	Annual	GHFT, CPT	X[c]	X	X[c]	X	X	X[c]
Sampler	Annual	GHFT, CPT						X

[a]The T Plant Complex Dangerous Waste Training Plan provides a complete description of coursework in each training category.

[b]Training types defined in Permit Attachment 5.

[c]This training is required only if workers are unescorted in the facility.

BED = Building Emergency Director
CPT = Contingency Plan Training
ECO = Environmental Compliance Officer
ECT = Emergency Coordinator Training
FS = Field Sampler
FWS = Field Work Supervisor
GHFT = General Hanford Facility Training
OT = Operations Training
SPOC = Single Point of Contact

H.1.4 Maintenance and Security During Closure

To maintain the 277-T Outdoor Storage Area in a compliant manner during closure, measures are taken to ensure inspections are performed, and security and emergency preparedness activities are in place.

H.1.4.1 Inspections

The 277-T Outdoor Storage Area will be closed in a manner that demonstrates that all steps to prevent threats to HHE have been met and will continue to be taken. After closure activities have been completed, the 277-T Outdoor Storage Area will be inspected annually until Ecology approves the unit closure certification. Table H-2 shows annual inspection requirements that will be performed.

Table H-2 277-T Outdoor Storage Area Inspection Schedule

Requirement Description	Frequency	DWMU Condition*
Signage	Annual	Warning signs are present and clearly legible.
Site – General	Annual	There is no evidence that unusual conditions exist at the closing DWMU site.

*The storage area is empty of dangerous and mixed waste. "No waste in storage" or equivalent words will be entered on the inspection log.

H.1.4.2 Facility Security

The following sections document security measures in effect at the T Plant Complex.

H.1.4.2.1 Security Provisions

Located within the 200 West Area of the Hanford Facility, the T Plant Complex complies with access control and warning sign requirements pursuant to WAC 173-303-310(1) and (2), *Security*.

Security measures are used to control access to the active portions of the Hanford Facility in accordance with Permit Condition II.M, Security.

The entire Hanford Facility is a controlled access area as described in Permit Attachment 3, *Security*. The security measures in Permit Attachment 3 and the unit-specific security measures prevent the unknowing entry, and minimize the possibility for the unauthorized entry, of persons or livestock. [WAC 173-303-310(1)]

H.1.4.2.2 T Plant Complex Access Control

Unknowing entry and the possibility for unauthorized entry of persons or livestock onto the active portions of the T Plant Complex are minimized through implementation and maintenance of the following security measures.

Access to T Plant DWMUs is controlled by an approximate 2.4 m (8 ft) high chain-link fence encircling the operating boundary (Figure H-1). A two-part swinging chain-link gate at the T Plant main entrance is open during operational hours to allow vehicle and personnel ingress to the parking lot and outdoor areas. Signs are posted at the main entrance instructing all visitors to check in at 271-T Building. This gate is closed and locked when personnel are away from T Plant. Alternate vehicle access gates, found about the fenced perimeter, are closed and locked except when in use. Keys to gates are controlled and accessible only by authorized personnel. [WAC 173-303-310(2)(c)]

Upon arrival at T Plant, visitors are required to sign in at the 271-T Building administration office, and must adhere to all personal protection requirements, and are subject to escorting protocols.

Section H.1.3.2 provides the personnel training requirements for T Plant Complex operators, workers, and visitors.

Access to the 277-T Outdoor Storage Area is restricted by the T Plant Complex access controls described above.

H.1.4.2.3 Warning Signs

Warning signs stating "Danger-Unauthorized Personnel Keep Out" are posted near the entrance gate of the T Plant Complex. Identical signs are posted along the perimeter fence lines at distances not to exceed 250 ft (76.2 m) between signs. Permittees must maintain warning signs at points described in this closure plan and ensure that signs are written in English, legible from a distance of 25 ft (approximately 7.6 m) or more, and visible from all angles of approach. [WAC 173-303-310(2)(a)]

H.1.4.3 Preparedness, Prevention, Emergency Procedures

T Plant preparedness, prevention, and emergency procedures are described in the following subsections. Contingency information is contained in the Building Emergency Plan for the T Plant Complex, as well as Permit Attachment 4, *Hanford Emergency Management Plan*.

H.1.4.3.1 T Plant Building Emergency Plan

The T Plant Complex is within the Hanford Facility. The Building Emergency Plan for the T Plant Complex describes facility-specific hazards and emergency planning and response. This site-specific plan is intended to be used in conjunction with Permit Attachment 4, *Hanford Emergency Management Plan*. If an emergency occurs, the on-call Building Emergency Director will be notified, and the requirements associated with Permit Attachment 4, *Hanford Emergency Management Plan* and the T Plant Complex Building Emergency Plan will be implemented. A copy of the T Plant Complex Building Emergency Plan is kept in the operating record.

H.1.4.3.2 Hanford Emergency Management Plan

Permit Attachment 4, *Hanford Emergency Management Plan*, addresses site emergency management and contingency plan requirements for the Hanford Facility.

H.1.4.4 Facility Recordkeeping

Historical records that describe dangerous and mixed waste management activities within the 277-T Outdoor Storage Area are retained in the operating record, which ensures proper availability and retention periods. These records describe the source of the chemicals, quantity, and hazards associated with the chemicals.

Records will be stored in either electronic or hardcopy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes to ensure the accuracy and retrievability of stored records. Records generated during closure will be maintained in the operating record in accordance with Permit Condition II.I.

H.1.5 Facility Contact Information

277-T Outdoor Storage Area Operator and Property Owner:

Brian T. Vance, Manager
U.S. Department of Energy, Richland Operations Office
P.O. Box 550
Richland, WA 99352
(509) 376-7395

277-T Outdoor Storage Area Co-Operator:

Scott Sax, President and Project Manager
Central Plateau Cleanup Company, LLC
P.O. Box 1464
Richland, WA 99352
(509) 372-3845

H.2 Closure Performance Standards

The 277-T Outdoor Storage Area will be closed in a manner that complies with the closure performance standards in WAC 173-303-610(2)(a) and (b) and, therefore, achieves clean closure. The objectives of closure activities for the 277-T Outdoor Storage Area are as follows:

- Minimize the need for further maintenance.
- Control, minimize, or eliminate to the extent necessary to protect HHE, post-closure escape of dangerous waste, dangerous constituents, leachate, contaminated runoff, or dangerous waste decomposition products to the ground, surface water, groundwater, or atmosphere.
- Remove all waste and waste residues.
- Decontaminate the concrete surface and perform concrete chip sampling to ensure concrete meets standard Model Toxics Control Act (MTCA) Method A or B cleanup levels, or remove any concrete that cannot be so decontaminated.
- Perform soil sampling and analysis to ensure soils in the 277-T Outdoor Storage Area meet standard MTCA Method A or B cleanup levels, and remove any soils (and adjacent asphalt associated with the contaminated soil) contaminated above these levels.
- Return the land to the appearance and use of surrounding land areas to the degree possible given the nature of the previous dangerous waste activity.

H.3 Closure Activities

The 277-T Outdoor Storage Area will be clean closed.

The following closure activities are required to achieve and certify clean closure:

- Remove all dangerous and mixed waste inventory (completed, Section H.3.1).
- Review dangerous and mixed waste container storage, operating, and inspection records for documented spills or releases of dangerous or mixed waste during periods of waste storage and subsequent cleanup (completed, Section H.3.2).
- Perform visual inspection of the concrete and asphalt surfaces to identify dangerous or mixed waste related staining, low points, joints/seams, cracks, holes, pits, or breaches significant enough to allow contamination to reach underlying soil. Evaluate surfaces to identify potential for focused sample locations (completed, Section H.3.2).
- Decontaminate the concrete pads using a site-specific decontamination method (Section H.3.4).
- Perform chip sampling of concrete pads (Section H.4.4).
- Perform soil sampling below concrete pads and blow-down drain (Sections H.4.4).
- Perform soil sampling beneath asphalt (Section H.4.4).
- Confirm analytical results from soil and concrete chip samples meet closure performance standards (Section H.3.10).

- Identify and manage contaminated environmental media (Section H.3.5).
- Identify and manage waste generated during closure (Section H.3.6).
- Transmit closure certification to Ecology (Section H.5.3).

H.3.1 Removal of Wastes and Waste Residues

No dangerous or mixed waste is currently stored at the 277-T Outdoor Storage Area. The 277-T Outdoor Storage Area will not be used for storage of dangerous or mixed waste in the future.

It is unknown if dangerous or mixed waste residues are present at this DWMU. If dangerous or mixed waste residues are found during clean closure activities, then the residues will be removed and managed as newly generated waste in accordance with Section H.3.6.

H.3.2 Operating Records Review and Visual Inspection

To support the development of this closure plan and the Sampling and Analysis Plan (SAP), a review of the T Plant Complex container storage, operating, and inspection records was completed and submitted to the operating record. The records review included the following operating record documents: facility operating logbooks (including spill reports), and waste management inspection and surveillance records. The operating records that were reviewed focused on the period during active waste storage for the T Plant Complex (i.e., January 1985 through June 2013) including:

- 271-T Cage.
- 211-T Pad.
- 221-T Sand Filter Pad.
- 277-T Outdoor Storage Area.
- 277-T Building.
- 221-T Railroad Cut.
- 2706-TB Tank System.
- 221-T Pipe Gallery Storage.
- 221-T R5 Waste Storage Area.
- 221-T Tank System.

The records review extended past the active waste storage period to June 2013. The records review indicated no releases of dangerous or mixed waste in the 277-T Outdoor Storage Area. Table H-3 provides a summary of the records review.

Waste management records reviewed in Table H-3 indicate that dangerous or mixed waste may have been previously managed in the 277-T Outdoor Storage Area in CAA or SAA storage areas. Since the 277-T Outdoor Storage Area was not permitted for dangerous or mixed waste storage, this area lacks sufficient documentation to clearly define the dangerous waste codes associated with the waste in storage in the CAAs and SAAs. Therefore, as a conservative measure, the target analytes for the 277-T Outdoor Storage Area (shown in Table H-4) were derived from the collective list of all dangerous waste codes identified during the records review of the T Plant Complex DWMUs.

Table H-3 Operating Records Review Summary

Document Title	Document Type	Time Frame of Records Reviewed		Items of Concern Noted
		Start Date	End Date	
T Plant Daily Operating Logbook	Logbook	01/02/1985	06/22/2010	No
T Plant Operation Logbook	Logbook	07/27/2010	04/07/2011	No
Waste Management Area Daily Inspection Data Sheet	Data Sheet	08/29/2005	12/01/2005	No
Waste Management Area Daily Inspection Data Sheet	Data Sheet	10/01/2007	04/22/2013	No
Weekly Surveillance Log, ≤90-day Storage Areas and Satellite Accumulation Areas	Log Sheet	06/07/1991	12/20/1999	No
Treatment Facility Waste Management Area Weekly Inspection Log Sheet Treatment Facility Waste Management Area Daily Inspection Log Sheet Treatment Facility Waste Management Area Weekly Inspection Data Sheet Weekly Waste Area Surveillance Treatment Facility Waste Management Area Daily Inspection Data Sheet T Plant Daily Waste Management Area Inspection Data Sheet	Inspection, Data, and Log Sheets	01/2000 01/2005	12/2002 12/2007	No
Waste Management Area Daily Inspection Report Weekly Waste Area Surveillance	Inspection Sheets	01/2003	12/2004	Yes*
T Plant Weekly Waste Management Area Inspection Data Sheet	Data Sheet	10/18/2007	06/12/2013	No

*Item of concern was a container of Insulkote® leaking in 271-T Cage. Product was determined to be nonregulated material.
Insulkote® is a registered trademark of Industrial Insulation Group, LLC, Brunswick, Georgia.

For the purposes of focused sampling, visual inspections were performed by the Permittees on August 29, 2013, and June 1, 2015, to identify any dangerous or mixed waste related staining, major cracks, crevices, pits, low areas, or joints/seams that would allow liquid to migrate to the soil. The Permittees inspections showed stains related to rusting equipment on the concrete pad in front of the 277-T Building and northwest corner of the asphalt area (see Attachment A). No dangerous or mixed waste related staining was identified during the visual inspections. During the visual inspection on June 1, 2015, two expansion joints and a steam condensate blow-down line drain were identified for focused sampling of the underlying soil.

Ecology and the Permittees performed an additional walk down and inspection of the DWMU in November of 2018. Ecology relocated the soil samples for the concrete expansion joints on the 277-T Building front concrete pad to the corners, and added two focused soil samples where each expansion joint meets up with the 277-T Building. Ecology added two focused soil samples to the front concrete pad, at points where remaining metal posts penetrate the concrete (Figure H-4). Ecology added

three focused soil samples to the 277-T Building back concrete pad at the low end of the concrete pad, and at an existing manhole cover (Figure H-3). Sample locations are identified in Figure H-7. Section H.4.4.1 provides details on the sample design for the focused samples.

Supporting documentation for the Permittees' visual inspections is included in Attachment A, *T Plant 277-T Outdoor Storage Area Visual Inspection Supporting Documentation*.

H.3.3 Unit Components, Parts, and Ancillary Equipment

The 277-T Outdoor Storage Area consists of concrete pads and asphalt surfaces and does not have any unit components, parts, or ancillary equipment identified for removal as part of closure. The 277-T Outdoor Storage Area will remain in place pending confirmation and acceptance of clean closure.

H.3.4 Decontamination

Decontamination of the concrete pads will be performed using the site-specific decontamination method of high-pressure steam or water sprays.

Decontamination includes the following steps:

1. Seal all significant cracks including expansion joints using an appropriate sealant material.
2. Decontaminate the concrete surface using the site-specific decontamination method as described below.

Site-specific decontamination method parameters have been evaluated, including water pressure, temperature, water spray distance and angle, in relation to the concrete surface. The water pressure applied to the concrete surface should not exceed a maximum of 2,500 psi. For worker safety protection, water temperature should not exceed 120°F. If the aid of a surfactant or detergent is necessary to achieve surface decontamination, then the product will be identified based on the nature of the staining and utilized in accordance with the manufacturer's instruction. The product, concentration used, and residence time of application will be documented in the clean closure certification.

The amount of water used will be minimized to prevent ponding and runoff. Water collection measures will be employed using portable berms to enclose the area subject to decontamination. A portable vacuum system will be used to control water accumulation throughout the duration of decontamination activities, and to collect rinsate from the surface area. Residual material, including rinsate from decontamination activities, will be managed as newly generated waste in accordance with Section H.3.6.

Equipment that becomes contaminated during decontamination and sampling activities will be decontaminated for re-use or managed and disposed of as newly generated waste in accordance with Section H.3.6. A temporary decontamination area may be established near the 277-T Outdoor Storage Area. This area will be constructed of Visqueen™ or an equivalent material, and may be used for decontamination of sampling equipment, personal protective equipment, and other miscellaneous small equipment used during decontamination and sampling activities. When decontamination of equipment is completed, the Visqueen™ or equivalent materials, rinsate, and solid waste debris generated by equipment decontamination (e.g., rags and personal protective equipment) will be removed and managed as newly generated waste in accordance with Section H.3.6.

H.3.5 Identifying and Managing Contaminated Environmental Media

The records review and visual inspection outlined in Section H.3.2 did not identify any releases of dangerous or mixed waste or the presence of staining that could be related to dangerous or mixed waste. Contaminated environmental media (soil) removal is not anticipated. However, contaminated soil will be remediated at focused and grid soil sampling locations where analytical results indicate contamination.

If contamination above closure performance standards is identified, then the nature and extent of contamination will be evaluated. Soil surrounding the sample location that identified soil contamination will be removed up to 4.6 m (15 ft) below the surface, and in the case of a grid sample node location will be removed up to the adjacent sampling node location. Contaminated soil will be removed using equipment capable of removing the quantity of material required to complete removal. If contamination exists in the soil deeper than 4.6 m (15 ft), the Permittees will collaborate with Ecology for a path forward on closure. Resulting changes to this closure plan will be submitted to Ecology as a permit modification request in accordance with Permit Condition I.C.3.

Contaminated soil will be removed and managed as a newly generated waste stream. Contaminated soil will be managed in accordance with all applicable requirements of WAC 173-303-170, *Requirements for generators of dangerous waste*, through 173-303-230, *Special conditions*. [WAC 173-303-610(5)]

The contaminated soil will be containerized, labeled, and sampled as needed to designate for disposal of the entire volumne of contaminated soil. Contaminated soil will be placed in U.S. Department of Transportation-compliant containers and sent to an appropriate land disposal unit, possibly with central accumulation as an intermediary step in accordance with all applicable requirements in WAC 173-303-200, *Conditions for exemption for a large quantity generator that accumulates dangerous waste*. Contaminated soil subject to the requirements of WAC 173-303-140, *Land disposal restrictions* (which incorporates by reference 40 Code of Federal Regulations [CFR] 268, *Land Disposal Restrictions*) will be characterized, designated, and treated, as applicable, prior to disposal in an appropriate land disposal unit.

H.3.6 Identifying and Managing Waste Generated During Closure

Contaminated concrete removal is not anticipated (see Section H.3.2). However, if contamination above closure performance standards is identified, the following options may be used:

- Re-decontaminate using high pressure steam or water sprays, followed by confirmatory concrete chip sampling to demonstrate re-decontamination was successful.
- Investigate the nature and extent of contamination. Remediate the concrete within the identified area of contamination by removing the affected concrete, followed by resampling to confirm contamination has been removed.
- Submit a permit modification request to treat concrete using one of the physical extraction methods, in accordance with 40 CFR 268.45 Alternative Treatment Standard for Hazardous Debris in Table 1.

Closure activities for the 277-T Outdoor Storage Area will result in waste generated from closure activities, requiring management and disposal. Small sections of concrete and asphalt surfaces will be removed in order to access the underlying soil and obtain focused and grid soil samples. Excess concrete will also be generated during chip sampling. Rinsate will be generated during concrete decontamination. Rinsate generated during concrete decontamination, and excess concrete and asphalt generated during soil and chip sampling will be collected, containerized, labeled, and sampled to properly characterize such waste prior to disposal. The waste will be managed as a newly generated waste stream and either disposed of or decontaminated in accordance with WAC 173-303-610(5).

Newly generated waste will be managed in accordance with all applicable requirements of WAC 173-303-170 through WAC 173-303-230. Once waste characterization results are received, all waste will be designated. Dangerous and mixed waste will be treated, if necessary, to meet land disposal restrictions in WAC 173-303-140 (which incorporates by reference 40 CFR 268) then ultimately disposed in an appropriate land disposal unit.

Management and disposal of waste generated during closure will be documented and included as part of the clean closure certification documentation (Section H.5.3).

H.3.7 Closure Performance Standards for Soil

The presumed exposure pathways considered for the 277-T Outdoor Storage Area are:

- WAC 173-340-740(3), Model Toxics Control Act (MTCA)—Cleanup, *Unrestricted land use soil cleanup standards* Method B (cancer and noncancer), which considers human health based on direct soil contact.
- WAC 173-340-740(2), Table 740-1, "Method A Soil Cleanup Levels for Unrestricted Land Uses" (WAC 173-340-900, *Tables*), which includes closure performance standards for human health based on unrestricted land use. MTCA Method A is only used if MTCA Method B is not available for a particular contaminant in the Cleanup Levels and Risk Calculation tables.
- WAC 173-340-747, *Deriving soil concentrations for groundwater protection,* which notes soil concentrations protective of groundwater.
- WAC 173-340-7493, *Site-specific terrestrial ecological evaluation procedures*, which considers ecological indicators (plants, biota, wildlife) in Table 749-3, "Ecological Indicator Soil Concentrations (mg/kg) for Protection of Terrestrial Plants and Animals" (WAC 173-340-900).
- WAC 173-340-750, *Cleanup standards to protect air quality,* which describes human health risks due to fugitive vapors and dust.

Of the exposure pathways listed above, direct soil contact is always considered a complete and viable exposure pathway for all soil samples. The exposure pathway for soil protective of groundwater assumes that water or precipitation on a surface has an avenue to percolate through the surface and underlying soil to groundwater. The scenario for ecological indicators requires that vegetation, biota, and wildlife be present in order for the pathway to be complete. The exposure scenario for inhalation of fugitive vapors and dust assumes a complete pathway, which would begin with a source of contaminated media and end with a receptor.

Of the viable exposure pathways, the most conservative closure performance standard is selected. Per WAC 173-340-740(5)(c), the closure performance standard value cannot be below the following:

- Hanford Site background.
- Laboratory practical quantitation limit (PQL) found in the CPCCo laboratory contracts.

If a closure performance standard is below both values, the higher of these two values is selected.

Two exposure pathways were considered complete pathways at 277-T Outdoor Storage Area—direct soil contact and soil levels protective of groundwater. The ecological indicator pathway and the inhalation exposure pathway were excluded when determining 277-T Outdoor Storage Area closure performance standards. Areas where focus and grid sampling will be conducted are treated to prevent growth of vegetation, so the ecological indicator pathway was excluded. As evidenced by the site inspection and record review (Section H.3.2), there was no known source of waste-contaminated media so the inhalation exposure pathway was also excluded.

Soil sampling and analysis will be conducted in accordance with the approved closure plan SAP located in Section H.4. Analytical results of the focused soil samples will be individually compared to closure performance standards consistent with closure requirements. [WAC 173-303-610(2)(b)(i)] If target analytes are found above closure performance standards, then the contaminated soil will be remediated and confirmatory sampling will be conducted in accordance with Section H.4.4.3 to ensure the closure performance standards are met for the remaining soil. If failed constituents of concern do not meet closure performance standards after soil remediation, then Permittees will meet with Ecology to determine a path forward for closure. Resulting changes to this closure plan will be submitted to Ecology as a permit modification request in accordance with Permit Condition I.C.3. The sample design for focused samples is discussed in Section H.4.4.1.

H.3.8 Closure Performance Standards for Concrete

The closure performance standard for concrete is treatment using a site-specific decontamination method as discussed in Section H.3.4, followed by confirmatory concrete chip sampling to ensure analytical results meet closure performance standards and that decontamination was successful.

Ecology Publication #94-111, Section 5.6, Decontamination of Concrete Containment Structures, states the following:

> Facility owners/operators, generators, and transporters have two options for decontaminating concrete: meet the operating and performance standards associated with the Alternative Treatment Standards for Hazardous Debris appropriate to concrete, or propose a site-specific decontamination method.

For the concrete pads at the 277-T Outdoor Storage Area, a site-specific decontamination method is an appropriate approach to achieve clean closure. Ecology Publication #94-111, Section 5.6.1, Decontamination Options for Concrete, acknowledges that concrete surface removal may not be necessary to achieve decontamination and may not be the best environmental solution considering the factors involved. In certain instances, site-specific closure performance standards may be the most viable approach. As stated in Ecology Publication #94-111, Section 5.3.2, Site-Specific Decontamination Methods:

> An example of a site-specific decontamination method is high-pressure water washing for decontamination of concrete that is over 1.2 cm (approximately ½ inches) thick instead of removal of the top 0.6 cm (approximately ¼ inches) of the concrete surface.

On completion of decontamination activities, the concrete pads will be chip sampled. The viable exposure pathways considered for concrete are the same as for soil (Section H.3.7). Concrete chip sampling and analysis will be conducted in accordance with the closure plan SAP located in Section H.4. Analytical results of the concrete chip samples will be individually compared to the soil closure performance standards consistent with closure requirements. [WAC 173-303-610(2)(b)(i)]

If target analytes are found above closure performance standards, the contaminated concrete will be remediated and confirmatory sampling will be conducted in accordance with Section H.4.4.3. If failed constituents of concern do not meet closure performance standards after remediation, then the Permittees will meet with Ecology to determine a path forward for closure. Resulting changes to this closure plan will be submitted to Ecology as a permit modification request in accordance with Permit Condition I.C.3. The sample design for concrete chip samples is discussed in Section H.4.4.1.

H.3.9 Closure Performance Standards for Asphalt

In most cases, asphalt would be removed and disposed of during closure; however, based on operating records, waste activities, and condition of the asphalt at this unit, it has been determined that the asphalt will remain in place after closure. The condition of the 277-T Building asphalt is as follows:

- Weathered and faded with little visible tar-like binding material,
- Does not visibly repel water (i.e. most of the surface absorbs water and remains wet for some time after rain events), and
- The surface is visibly broken and rough (i.e. looks more like gravel than asphalt).

This is an indication of high porosity and loss of the organic material that binds asphalt and aggregate together. As a result, the asphalt is considered permeable to precipitation and may allow percolation of contaminants to the groundwater. For these reasons, it can be inferred that any contamination on the asphalt surface would have migrated to the underlying soil.

As a result, the point of compliance for asphalt areas is the soil beneath the asphalt. The viable exposure pathways considered for soil beneath the asphalt are the same as the pathways considered for other soil samples (Section H.3.7).

Soil grab samples will be collected following the grid sampling design described in Section H.4.4.1. Soil sampling and analysis will be conducted in accordance with the closure plan SAP located in Section H.4. Analytical results of grid samples will be evaluated in the Visual Sample Plan (VSP[1]) data analysis function to generate the Data Analysis Report and follow the MTCA three-part test (also described in Section H.4.4.1) to determine if closure performance standards have been met. A copy of the VSP Data Analysis Report is to be provided to Ecology within 30 days of receipt of the final laboratory analytical report.

If target analytes are found above closure performance standards, then the contaminated soil, and any asphalt associated with the contamination, will be remediated and confirmatory sampling will be conducted in accordance with Section H.4.4.3 to ensure the closure performance standards are met for the remaining soil. If failed constituents of concern remain above closure performance standards after soil remediation, then Permittees will meet with Ecology to determine a path forward for closure. Resulting changes to this closure plan will be submitted to Ecology as a permit modification request in accordance with Permit Condition I.C.3. The sample design for grid soil samples is discussed in Section H.4.4.1.

H.3.10 Development of Closure Performance Standards

The target analytes considered for evaluation during closure sampling and analysis were derived from a list of all waste codes identified at other T Plant closure DWMUs. Table H-4 provides the closure performance standards for soil and concrete for each individual target analyte associated with the dangerous waste codes identified. A list of closure performance standard values for all exposure pathways was provided to Ecology in July 2017 as correspondence from DOE (17-AMRP-0217, “Dangerous Waste Management Unit [DWMU] 277-T Building Closure Plan Comment Disposition, and Performance Standards for Future Solid Waste Operations Complex [SWOC] Closure Plans”), which Ecology acknowledged (17-NWP-100, “Dangerous Waste Management Unit [DWMU] 277-T Building Closure Plan Comment Disposition and Performance Standards for Future Solid Waste Operations Complex [SWOC] Closure Plans”). Values in Table H-4 have been adjusted to remove nonviable pathways as noted above.

[1]Visual Sample Plan is a product of Pacific Northwest National Laboratory (PNNL), Richland, Washington.

Table H-4 Closure Performance Standards for Soil and Concrete and Analytical Performance Requirements

CAS Number	Waste Code(s)[a]	Analyte	Closure Performance Standards		PQL[b] (mg/kg)
			Value (mg/kg)	Basis	
SW-846 Method 6010			**Accuracy Requirement ±20% Recovery[c] Precision Requirement ≤35 RPD[d]**		
7440-38-2	D004	Arsenic[e]	2.00E+01	Background	1.00E+00
7440-39-3	D005	Barium	1.65E+03	Groundwater Protection	5.00E+00
7440-43-9	D006	Cadmium	6.90E-01	Groundwater Protection	5.00E-01
7439-92-1	D008	Lead	2.50E+02	Unrestricted Land Use (MTCA Method A)	5.00E+00
7782-49-2	D010	Selenium	1.00E+01	PQL	1.00E+01
7440-22-4	D011	Silver	1.36E+01	Groundwater Protection	1.00E+00
1314-62-1 (7440-62-2)	(P120)	Vanadium pentoxide (analyzed as vanadium)	4.00E+02	Human Health – Direct Contact (noncancer)	5.00E+00
SW-846 Method 6020			**Accuracy Requirement ±20% Recovery[c] Precision Requirement ≤35 RPD[d]**		
7440-38-2	D004	Arsenic[e]	2.00E+01	Background	1.00E+00
SW-846 Method 7196			**Accuracy Requirement ±20% Recovery[c] Precision Requirement ≤35 RPD[d]**		
18540-29-9	D007	Chromium (Hexavalent)	5.00E-01	PQL	5.00E-01
SW-846 Method 7471			**Accuracy Requirement ±20% Recovery[c] Precision Requirement ≤35 RPD[d]**		
7439-97-6	D009	Mercury[f]	2.09E+00	Groundwater Protection	2.00E-01
SW-846 Method 8015			**Accuracy Requirement ±30% Recovery[c] Precision Requirement ≤30 RPD[d]**		
67-56-1	F003	Methanol	6.43E+01	Groundwater Protection	5.00E+01
SW-846 Method 8260			**Accuracy Requirement ±30% Recovery[c] Precision Requirement ≤20 RPD[d]**		
67-64-1	F003	Acetone	2.89E+01	Groundwater Protection	2.00E-02
71-43-2	D018, F005	Benzene	2.82E-02	Groundwater Protection	5.00E-03
71-36-3	(U031), F003	*n*-Butyl alcohol (1-Butanol)	3.31E+00	Groundwater Protection	2.50E-01
75-15-0	F005, (P022)	Carbon disulfide	5.65E+00	Groundwater Protection	5.00E-03
56-23-5	D019, F001, F002	Carbon tetrachloride	4.60E-02	Groundwater Protection	5.00E-03
108-90-7	F002	Chlorobenzene	8.74E-01	Groundwater Protection	5.00E-03
67-66-3	D022	Chloroform	7.50E-02	Groundwater Protection	5.00E-03
108-94-1	F003, (U057)	Cyclohexanone	1.74E+02	Groundwater Protection	1.00E-01
123-91-1	(U108)	1,4-Dioxane	1.00E+01	Human Health – Direct Contact (cancer)	5.00E-01
141-78-6	F003	Ethyl acetate	2.97E+01	Groundwater Protection	5.00E+00
100-41-4	F003	Ethylbenzene	3.44E-01	Groundwater Protection	5.00E-03

Table H-4 Closure Performance Standards for Soil and Concrete and Analytical Performance Requirements

CAS Number	Waste Code(s)[a]	Analyte	Closure Performance Standards		PQL[b] (mg/kg)
			Value (mg/kg)	Basis	
60-29-7	(U117), F003	Diethyl ether [ethyl ether, ethoxyethane, or 1,1'-oxybis-ethane]	6.85E+00	Groundwater Protection	1.00E-02
78-83-1	F005	Isobutanol	9.70E+00	Groundwater Protection	5.00E-01
78-93-3	D035, F005	Methyl ethyl ketone (MEK) (2-Butanone)	1.96E+01	Groundwater Protection	2.00E-02
108-10-1	F003, (U161)	Methyl isobutyl ketone (4-Methyl-2-Pentanone)	2.73E+00	Groundwater Protection	2.00E-02
75-09-2	F001, F002	Methylene chloride	2.18E-02	Groundwater Protection	5.00E-03
127-18-4	D039, F001, F002	Tetrachloroethylene	5.30E-02	Groundwater Protection	5.00E-03
109-99-9	(U213)	Tetrahydrofuran	3.00E+01	Groundwater Protection	5.00E-02
108-88-3	F005	Toluene	4.65E+00	Groundwater Protection	5.00E-03
71-55-6	F001, F002, (U226)	1,1,1-Trichloroethane	1.58E+00	Groundwater Protection	5.00E-03
79-00-5	F002	1,1,2-Trichloroethane	2.78E-02	Groundwater Protection	5.00E-03
79-01-6	D040, F001, F002	Trichloroethylene	2.64E-02	Groundwater Protection	5.00E-03
76-13-1	F001, F002	1,1,2-Trichloro-1,2,2-trifluoroethane	1.09E+04	Groundwater Protection	1.00E-02
75-69-4	F002	Trichlorofluoromethane	2.84E+01	Groundwater Protection	1.00E-02
75-01-4	D043	Vinyl chloride	1.00E-02	PQL	1.00E-02
1330-20-7	F003	Xylenes (total)	1.46E+01	Groundwater Protection	1.00E-02
SW-846 Method 8270			**Accuracy Requirement ±30% Recovery[c] Precision Requirement ≤30 RPD[d]**		
95-48-7	F004	*o*-Cresol reported as total cresols[g]	2.33E+00	Groundwater Protection	3.33E-01
121-14-2	D030	2,4-Dinitrotoluene	3.33E-01	PQL	3.33E-01
95-50-1	F002	1,2-Dichlorobenzene (Ortho-dichlorobenzene)	7.03E+00	Groundwater Protection	3.33E-01
111-44-4	(U025)	bis (2-chloroethyl) ether (dichloroethyl ether)	3.33E-01	PQL	3.33E-01
67-72-1	D034	Hexachloroethane	3.33E-01	PQL	3.33E-01
98-95-3	F004	Nitrobenzene	3.33E-01	PQL	3.33E-01
87-86-5	D037	Pentachlorophenol	6.60E-01	PQL	6.60E-01
110-86-1	F005	Pyridine	6.60E-01	PQL	6.60E-01
SW-846 Method 9012			**Accuracy Requirement ±20% Recovery[c] Precision Requirement ≤35 RPD[d]**		
57-12-5	(P030)	Cyanides, Total[h] (soluble cyanide salts)	1.94E+00	Groundwater Protection	1.00E+00

Table H-4 Closure Performance Standards for Soil and Concrete and Analytical Performance Requirements

CAS Number	Waste Code(s)[a]	Analyte	Closure Performance Standards		PQL[b] (mg/kg)
			Value (mg/kg)	Basis	
SW-846 Method 9056			**Accuracy Requirement ±20% Recovery[c] Precision Requirement ≤35 RPD[d]**		
64-18-6	(U123)	Formic acid (measured as Formate)	7.20E+04	Human Health – Direct Contact (noncancer)	1.00E+01
Not Analyzed			**Not Analyzed**		

CAS Number	Waste Code(s)	Analyte	CAS Number	Waste Code(s)	Analyte
75-07-0	(U001)	Acetaldehyde[i]	1338-23-4	U160	MEK peroxide[j] (2-Butanone peroxide)
75-36-5	(U006)	Acetyl chloride[j]	79-46-9	F005	2-Nitropropane[i]
107-20-0	(P023)	Chloroacetaldehyde[k]	1314-80-3	U189	Phosphorus pentasulfide[j]
110-80-5	F005, (U359)	2-Ethoxyethanol[l]	N/A	F001, F002	Chlorinated fluorocarbons[m]

References:

17-AMRP-0217, "Dangerous Waste Management Unit (DWMU) 277-T Building Closure Plan Comment Disposition, and Performance Standards for Future Solid Waste Operations Complex (SWOC) Closure Plans."

17-NWP-100, "Dangerous Waste Management Unit (DWMU) 277-T Building Closure Plan Comment Disposition and Performance Standards for Future Solid Waste Operations Complex (SWOC) Closure Plans."

DOE/RL-92-24, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*.

ECF-HANFORD-11-0038, *Soil Background for Interim Use at the Hanford Site*.

Ecology, 2005, Pub. #94-111, *Guidance for Clean Closure of Dangerous Waste Units and Facilities*. Section 5.6.2 states, "…Ecology believes that MTCA unrestricted site use cleanup levels for soil represent very conservative assessments of the potential exposure risks posed by concrete."

Ecology, 2013, "Issues associated with Establishing Soil Cleanup Levels for arsenic."

Ecology, 2019, *Cleanup Levels and Risk Calculation (CLARC)* Data Tables, Toxics Cleanup Program.

Howard et al., 1991, *Handbook of Environmental Degradation Rates*.

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, Third Edition; Final Update V.

WAC 173-340, *Model Toxics Control Act—Cleanup*.

173-340-740, *Unrestricted land use soil cleanup standards*.

173-340-747, *Deriving soil concentrations for groundwater protection.*

Notes: Screening levels considered when developing closure performance standards were drawn from the following:

- MTCA (WAC 173-340-740, Model Toxics Control Act—Cleanup, *Unrestricted land use soil cleanup standards*) (Ecology, 2019, *Cleanup Levels and Risk Calculation [CLARC]* Tables, May 2019 data tables are most recent). MTCA Method B values represent both cancer and noncancer human health risk values from direct soil contact. The most conservative value of the two Method B published values will be used. Method A values are substituted when MTCA Method B values are not provided in the CLARC tables.
- WAC 173-340-747. Section 4 describes the fixed parameter three-phase partitioning model. Where applicable, these values were used. Values selected were from the 25°C vadose zone. If values were not listed for 25°C, values from the 13°C vadose zone were used.
- Background levels as published in ECF-HANFORD-11-0038, *Soil Background for Interim Use at the Hanford Site*, and DOE/RL-92-24, *Hanford Site Background: Soil Background for Nonradioactive Analytes*. Background values were used at the 90th percentile of calculated Hanford Site background values.

Table H-4 Closure Performance Standards for Soil and Concrete and Analytical Performance Requirements

CAS Number	Waste Code(s)[a]	Analyte	Closure Performance Standards		PQL[b] (mg/kg)
			Value (mg/kg)	Basis	

- Closure performance standard values for all exposure pathways were provided to Ecology in July 2017 correspondence from DOE (17-AMRP-0217) and which values Ecology acknowledged (17-NWP-100). Values in this table have been adjusted to remove nonviable pathways.
- Values taken from the above resources that fell below background levels were not considered.

[a]Many of the chemicals listed in this table also have P and U waste codes associated with them (WAC 173-303-9903, *Discarded chemical products lists*). (1) These codes are listed in the table because it is unknown whether or not the waste container had a "discarded chemical product" (per WAC 173-303-081) or if it was a chemical contaminant of the waste. (2) The P and U code designations do play a part in the determination of dangerous waste criteria (WAC 173-303-100), as they indicate that chemical as either acutely hazardous (P) or dangerous (U) waste based on toxicity and/or persistence calculations. For these reasons, the P and U codes are listed in parentheses.

[b]Highest allowable PQL will be defined in the individual laboratory contract with CPCCo. In practice, the laboratory PQL values have the potential to be lower.

[c]Accuracy criteria for associated batch matrix spike percent recoveries. Evaluation based on statistical control of laboratory control samples is also performed. Precision criteria for batch laboratory replicate matrix spike analyses or replicate sample analysis.

[d]Precision is determined by the laboratory based on historical data or statistically derived control limits. Limits are reported with the data. Where specific acceptance criteria are listed, those acceptance criteria may be used in place of statistically derived acceptance criteria.

[e]Arsenic – the Hanford Site closure performance standard is 20 mg/kg based on a letter (Ecology, 2013, "Issues Associated with Establishing Soil Cleanup Levels for Arsenic") indicating that the Method A soil closure performance standard of 20 mg/kg can be used to define natural background levels when developing Method B soil closure performance standards for the Hanford Site. One of the two methods (SW-846 6010 or 6020) may be used.

[f]Mercury – Equation 740-1 and Equation 740-2 from WAC 173-340-740(3)(b) are used to calculate the MTCA Direct Contact Human Health soil closure performance standards. The MTCA human health direct contact soil closure performance standard for mercury is calculated to be 24 mg/kg.

[g]Cresols – the closure performance standard for *o*-cresol will be reported as total cresols: a total of the three isomeric forms: *o*-cresol, *m*-cresol, and *p*-cresol.

[h]Cyanides – Copper (P029), potassium (P098), and sodium (P106) cyanides, as well as other cyanide salts not specified will be analyzed as total cyanide.

[i]Acetaldehyde and 2-nitropropane are listed with inhalation values in the CLARC Tables. However, because the inhalation pathway is not being addressed as part of this closure plan, they will not be analyzed.

[j]Acetyl chloride, MEK peroxide, and phosphorus pentasulfide are not listed in the CLARC Tables. They would most likely be inhalation hazards if present (based on NIOSH chemical hazard data), so they are not being calculated as closure performance standards and will not be analyzed.

[k]Chloroacetaldehyde – No previous records of analysis on the Hanford Site. CAS is not listed in the CLARC tables. Chloroacetaldehyde is not listed in the CLARC Tables. It would most likely be an inhalation hazard if present, so it is not being calculated as a closure performance standard and will not be analyzed.

[l]2-Ethoxyethanol – Due to the extremely short half-life of 2-ethoxyethanol (between 168 and 672 hours), its presence in soil samples is highly unlikely; therefore, samples will not be analyzed for this constituent. Degradation rates from Howard et al., 1991, *Handbook of Environmental Degradation Rates*, p. 420.

[m]A CFC is an organic compound that contains only carbon, chlorine, and fluorine, produced as a volatile derivative of methane, ethane, and propane. Examples of CFCs include 1,1,2-trichloro-1,2,2-trifluoroethane (CFC-133) and trifluoromethane (CFC-11).

CAS = Chemical Abstracts Service
CFC = Chlorofluorocarbon
CLARC = Cleanup Levels and Risk Calculation
CPCCo = Central Plateau Cleanup Company, LLC
MTCA = Model Toxics Control Act–Cleanup
N/A = Not applicable
PQL = Practical quantitation limit
RPD = Relative percent difference

1

H.3.11 Conditions That Will be Achieved When Closure is Complete

Upon completion of closure activities, the 277-T Outdoor Storage Area will remain in an "as-is" state with the concrete and asphalt pads remaining in place. Once Ecology accepts the clean closure certification, a permit modification request will be submitted to remove the 277-T Outdoor Storage Area DWMU closure requirements from the Permit.

H.4 Sampling and Analysis Plan

Sampling and analysis of the 277-T Outdoor Storage Area concrete and soil will be conducted to confirm whether closure performance standards have been met. Sampling includes 10 focused soil samples, 9 grid (non-statistical) concrete chip samples, and 21 grid (area-wide) soil samples (Figure H-7). Sampling and analysis will be performed in accordance with the sampling and quality standards established in this closure SAP.

H.4.1 Sampling and Analysis Plan Requirements

Sampling and analysis activities were designed using the EPA guidance document EPA/240/R-02/005, *Guidance on Choosing a Sampling Design for Environmental Data Collection for Use in Developing a Quality Assurance Project Plan* (EPA QA/G-5S) and Ecology Publication #94-111, and will be conducted via this SAP. The objective of the soil and concrete sampling described in this section is to determine if the closure performance standards (Table H-4) established in this closure plan pursuant to WAC 173-303-610(2)(b)(i) and WAC 173-303-610(2)(b)(ii) have been satisfied, demonstrating clean closure for the 277-T Outdoor Storage Area.

The closure SAP details sampling and analysis procedures in accordance with SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, Third Edition; Final Update V; the American Society for Testing and Materials (ASTM) *Annual Book of ASTM Standards* (ASTM International, 2017); and applicable EPA guidance. Sampling and analysis activities will meet applicable requirements of SW-846, ASTM standards, and EPA-approved methods at the time of closure. This SAP was also developed using guidance from Ecology Publication #94-111, Section 7.0, Sampling and Analysis for Clean Closure, and EPA/240/R-02/005.

H.4.2 Sampling and Analysis Schedule

Closure sampling and analysis will be performed in accordance with the closure plan schedule located in Section H.6.

H.4.3 Project Management

The following subsections address project management and ensure that the project has defined goals, participants understand the goals and approaches used, and planned outputs are appropriately documented. Project management roles and responsibilities discussed in this section apply to the major activities covered under this SAP.

H.4.3.1 Project/Task Organization

The Permittees are responsible for planning, coordinating, sampling, preparing, packaging, and shipping samples to the contract analytical laboratory. The project has the following key positions.

Regulatory Representative. Ecology will assign an Ecology employee as Project Manager responsible for oversight of the 277-T Outdoor Storage Area closure.

Project Manager and Technical Lead. The CPCCo Project Manager provides oversight of closure activities and coordinates with the U.S. Department of Energy, Richland Operations Office (DOE-RL), Ecology, and contract management. In addition, support is provided to the project technical lead to ensure that work is performed safely and cost effectively.

The Project Manager (or designee) for the 277-T Outdoor Storage Area closure sampling is responsible for direct management of sampling documents and requirements, field activities, and subcontracted tasks. The Project Manager is responsible for ensuring that project personnel are working to the approved version of the 277-T Outdoor Storage Area Closure Plan in the Permit and for providing updates to field personnel.

The Project Manager works closely with QA, Health and Safety, and the Field Work Supervisor (FWS) to integrate these and other lead disciplines in planning and implementing the work scope. The Project Manager also coordinates with DOE-RL and the primary contractor management on all sampling activities. The Project Manager supports DOE-RL in coordinating sampling activities with the Regulatory Representative.

Environmental Compliance Officer. The Environmental Compliance Officer provides technical oversight, direction, and acceptance of project and subcontracted environmental work, and develops appropriate mitigation measures with a goal of minimizing adverse environmental impacts.

Health and Safety. The Health and Safety organization is responsible for coordinating industrial safety and health support within the project, as carried out through health and safety plans, job hazard analyses, and other pertinent safety documents required by federal regulation or internal primary contractor work requirements.

Waste Management Lead. The Waste Management Lead communicates policies and protocols, and ensures project compliance for storage, transportation, disposal, and waste tracking.

Field Work Supervisor. The FWS is responsible for planning and coordinating field sampling resources. The FWS ensures that samplers are appropriately trained and available. Additional related responsibilities include ensuring that the sampling design is achievable, understood, and can be performed as specified.

The FWS must document all deviations from procedures or other problems pertaining to sample collection, chain-of-custody (COC) protocols, analytes, sample analysis, sample transport, or noncompliant monitoring. As appropriate, such deviations or problems will be documented in the field logbook or in nonconformance report forms in accordance with internal corrective action procedures. The FWS is responsible for communicating field corrective actions to the Project Manager and for ensuring that immediate corrective actions are applied to field activities.

Sample Management and Reporting. The Permittee's sampling organization coordinates field sampling as well as laboratory analytical work, ensuring that laboratories conform to the specifications of SW-846 analytical methodology at the time of closure. The sampling organization receives the analytical data from the laboratories, performs the data entry into the Hanford Environmental Information System (HEIS) database, and arranges for data validation. The sampling organization is responsible for informing the Project Manager of any issues reported by the contract analytical laboratory.

Contract Laboratories. The contract laboratories analyze samples in accordance with established procedures and provide necessary sample reports and explanation of results in support of data validation.

The roles described above make up the project organization structure (regarding sampling and analysis) and interact in a manner shown graphically in Figure H-6.

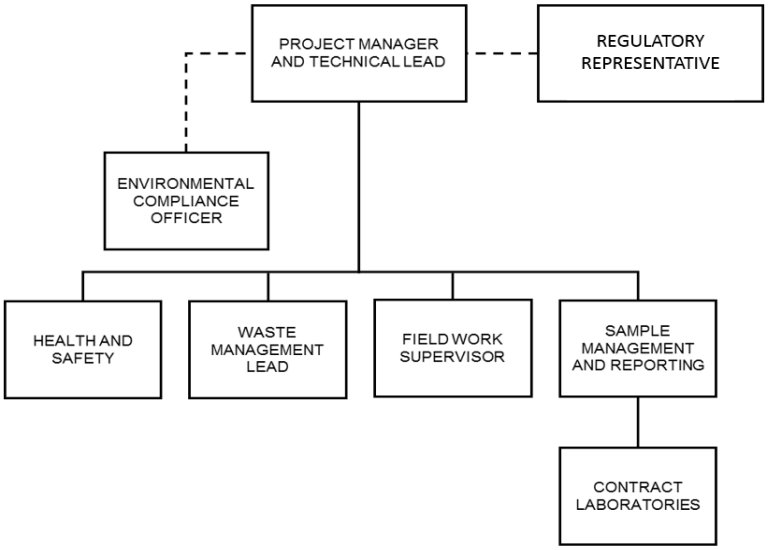

Figure H-6 Sampling and Analysis Plan Project Organization

H.4.3.2 Field Sampler Training/Certification

Training records of field samplers are maintained by the sampling organization, retained in the electronic training record database, or archived with operating records. Field samplers will be collecting grab samples of the soil beneath the concrete and asphalt, and concrete chip samples from the concrete pads for analysis to determine if closure performance standards have been met.

H.4.3.3 Sampling Documents and Records

The Project Manager is responsible for ensuring that the current version of the SAP is being used and providing any updates to field personnel. Version control is maintained by the administrative document control process. Changes to the SAP affecting the data needs will be submitted as a permit modification request.

Logbooks are required for field activities. A logbook must be identified with a unique project name and number. The individual(s) responsible for logbooks will be identified in the front of the logbook and only authorized persons may make entries in logbooks. After review, logbooks will be signed by the field manager, supervisor, cognizant scientist/engineer, or other responsible individual. Logbooks will be permanently bound, waterproof, and ruled with sequentially numbered pages. Pages will not be removed from logbooks for any reason. Entries will be made in indelible ink. Corrections will be made by marking through the erroneous data with a single line, entering the correct data, and initialing and dating the changes.

The Project Manager is responsible for ensuring that a project file is properly maintained. The project file will contain the records or references to their storage locations. The following items will be included in the project file, as appropriate:

- Field logbooks or operational records.
- Global positioning system data.
- Sample authorization forms.
- Data forms.
- COC forms.

- Sample receipt records.
- Inspection or assessment reports and corrective action reports.
- Interim progress reports.
- Final reports.
- Laboratory data packages.
- Data verification and validation reports.

The contract analytical laboratory is responsible for maintaining, and having available upon request, the following items:

- Analytical logbooks.
- Raw data and Quality Control (QC) sample records.
- Standard reference material or proficiency test sample data.
- Instrument calibration information.

Records will be stored in accordance with Section H.1.4.4.

H.4.4 Sampling Design and Analysis

The sampling design includes input parameters used to determine the number and location of samples. The primary purpose of sampling the concrete and soil is to determine if analytical results meet closure performance standards (Table H-4).

H.4.4.1 Sampling Process Design

This SAP is based on guidance from Ecology Publication #94-111, Section 7.0, to determine the type of sampling design that will be used to demonstrate clean closure. When designing the sampling plan, both focused and grid (area-wide) sampling methods were considered. The basis for focused and grid sampling is described in the following paragraphs.

Grid (Area-Wide) Soil Sampling. Ecology Publication #94-111, Section 7.2.1, Area-Wide Sampling, identifies that grid sampling is appropriate when the spatial distribution of contamination at or from the closure unit is uncertain. Ecology Publication #94-111, Section 7.3, Sampling to Determine or Confirm Clean Closure, identifies the grid sampling approach as generally appropriate for sampling to determine or confirm whether closure performance standards are achieved.

In grid sampling, grab samples are collected at regularly-spaced intervals over an area (called sample node locations). An initial location or time is chosen at random, and then the remaining sample node locations are defined so the locations are at regular intervals over an area (grid). Grid sampling is used to search for hot spots and to infer means, percentiles, or other parameters, and is useful for estimating spatial patterns or trends over time. This design provides a practical method for designating grab sample node locations and ensures uniform coverage of a site, unit, or process.

The quantity and location of sample nodes for the soil underlying the asphalt areas within the 277-T Outdoor Storage Area were determined using the VSP software. VSP is a tool used throughout Washington State and nationally that statistically determines the quantity of samples required to accept or reject the null hypothesis based on input parameters specific to the unit or area. A null hypothesis is generally assumed true until evidence indicates otherwise. The null hypothesis, as defined in WAC 173-340-200, *Definitions*, for the 277-T Outdoor Storage Area is that soil under the asphalt is assumed to be above closure performance standards as defined in Section H.3.10. Therefore, the soil is presumed to be contaminated. Rejection of the null hypothesis means results of field sampling and laboratory analysis indicated that soil meets closure performance standards.

Should sampling and analysis provide a basis that the null hypothesis can be accepted, such an event will be considered an unexpected event during closure, and the soil would then be identified as contaminated environmental media and managed in accordance with Section H.3.5.

For grid sampling determination in VSP, both parametric and nonparametric equations rely on assumptions about the data population. Typically, however, nonparametric equations require fewer assumptions and allow for more uncertainty about the distribution of data. Alternatively, if parametric assumptions are valid, the required number of samples is usually less than if a nonparametric equation was used.

For the 277-T Outdoor Storage Area, data assumptions were based on a DQO process performed in accordance with EPA/240/R-02/005. VSP parameter inputs, which are based on the DQO process, are detailed in Table H-5.

The decision rule for demonstrating compliance with the closure performance standards, which are based on MTCA (WAC 173-340) Method B, includes a three-part test that compares sample results to the closure performance standards:

- The 95% upper confidence limit on the true data mean must be less than the MTCA Method B cleanup level.
- No sample concentration can be more than twice the applicable cleanup level.
- Less than 10% of the samples can exceed the applicable cleanup levels.

Using a nonparametric test and the input parameters identified in Table H-5, VSP calculated that 21 samples would adequately describe the population. With this level of confidence in the population description, the null hypotheses could be rejected with 95% confidence and ensure that a site would not be mistakenly released as clean (uncontaminated). The VSP software compares the site mean to a fixed threshold in order to accept or reject the null hypothesis. Data will be evaluated to ensure that less than 10% of the individual values exceed MTCA (WAC 173-340) Method B cleanup levels and that no values are more than twice the cleanup level.

Grid sample node locations were determined using the grid with a random start sampling method run in the VSP software. Statistical analysis of systematically collected data is valid if a random start to the grid is used. The dimensions of the 277-T Outdoor Storage Area were entered into VSP to determine the locations of the sample nodes. The triangular grid sampling layout was determined to have an even distribution over the asphalt areas within the 277-T Outdoor Storage Area; thus, providing the most representative data set including coverage of the middle portion of the sampling area. The 21 samples will be taken from the node locations indicated by the VSP software (shown in Figure H-7) and will be assigned sample location identifications and sample numbers using the HEIS database.

The first node location is chosen at random by the VSP software, and the subsequent 20 sample locations are assigned by the VSP software using a triangular grid sampling method to achieve an even distribution.

Supporting documentation for the VSP software sampling designations is provided in Attachment B, *T Plant 277-T Outdoor Storage Area Visual Sample Plan Supporting Documentation*.

Table H-5 Visual Sample Plan Parameter Inputs for Grid (Area-Wide) Soil Sampling

Parameter	Value	Basis
Primary Objective of the Sampling Design	Null hypothesis	Compare a site mean or median to a fixed threshold. The basis is that the null hypothesis is true (site is contaminated). Clean closure requires rejection of the null hypothesis.
Type of Sampling Design	Nonparametric	Data are not assumed to be normally distributed.
Working Null Hypothesis	The mean value exceeds the threshold	The null hypothesis assumes that the site is dirty, requiring the sampling and analysis to demonstrate through statistical analysis that the site is clean (MTCA [WAC 173-340] Method B closure performance standards).
Grid Sampling Pattern	Triangular	A triangular pattern provided an even distribution of sample locations over asphalt areas within the 277-T Outdoor Storage Area.
Standard Deviation (S)	45%	This is the assumed standard deviation value relative to a unit action level for the sampling area. The value of 45% is conservative, based on consideration of past verification sampling. (Number of samples calculated increases with higher standard deviation values relative to a unit action level.)
Delta (Δ)	40%	This is the width of the grey region. It is a user-defined value relative to a unit action level. The value of 40% balances unnecessary remediation cost with sampling cost. A Type II error with the grey region would result in cleanup of a site that is already clean.
Alpha (α)	5%	This is the acceptable error of deciding a dirty site is clean when the true mean is equal to the action level. It is a maximum error rate since dirty sites with a true mean above the action level will be easier to detect. A value of 5% was chosen as a practical balance between health risks and sampling cost.
Beta (β)	20%	This is the acceptable error of deciding a clean site is dirty when the true mean is at the lower bound of the grey region. A value of 20% was chosen during the DQO process as a practical balance between unnecessary remediation cost and sampling cost.
MARSSIM sampling overage	20%	MARSSIM suggests that the number of samples should be increased by at least 20% to account for missing or unusable data and uncertainty in the calculated value of *n*.

Reference: EPA 402-R-97-016, *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM).

WAC 173-340, *Model Toxics Control Act—Cleanup*.

DQO = Data quality objective

MTCA = Model Toxics Control Act—Cleanup

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Focused (Judgmental) Sampling. As identified in Ecology Publication #94-111, Section 7.2.2, Focused Sampling, this method is selective sampling of areas where contamination is expected or releases have been documented.

Focused sampling should be conducted in addition to grid sampling where there is evidence of leaks or spills or potential for a dangerous waste constituent to migrate. Focused sampling could involve liner sampling along a drainage-way, boundary, or other linear dimension. Likely areas for focused sampling include, but are not limited to:

- Containers, tanks, waste piles, or any other units (such as ancillary pipes) in contact with soil;
- Below any sumps or valves;
- Load or unload areas;
- Storage units with underlying pavements or concrete that appears to be cracked or broken; and
- Areas receiving runoff or discharge from DWMUs, such as a ditch, a swale, or the discharge point down gradient from a pipe.

Evidence for additional areas of focused sampling could include:

- Visual or olfactory evidence of contamination including evidence based on direct reading field instrumentation or field test kits;
- Knowledge, such as reports by employees, inspectors, or others that releases have or may have occurred;
- Length of time the unit has been in existence;
- Entries into the unit operating record; and
- Soil gas surveys or soil borings.

Per the visual inspections (Section H.3.2) and Ecology's professional judgment, nine focused soil sample locations are identified for both concrete pads (six for the concrete pad located at the front of the 277-T Building, and three for the concrete pad located at the back of the 277-T Building). One focused soil sample is located at the blow-down line drain (Figure H-7).

For the front concrete pad, the concrete seams and the remaining metal posts in the concrete are considered possible avenues for waste to migrate to the soil. For the back concrete pad, the existing manhole and the low end of the sloping concrete pad are also considered possible avenues for waste to migrate to the soil. The blow-down line carried steam condensate from the 277-T Building steam heating system and discharged the condensate at the gravel drain. The drain terminates at the soil. Therefore, these locations were identified for focused soil sampling.

Selection of focused sampling units (i.e., the number and location of samples) is generally based on knowledge of the feature or condition under investigation and on professional judgment. Focused sampling is distinguished from probability-based sampling in that inferences are based on professional judgment, not statistical scientific theory. Therefore, conclusions about the target population are limited and depend entirely on the validity and accuracy of professional judgment.

The use of statistical evaluation for focused data is not possible. Any focused data must be reviewed directly against the closure performance standards as to whether they are above or below the standards.

Grid (Non-Statistical) Chip Sampling. The proposed site-specific decontamination method of high-pressure steam or water washing is chosen for decontamination of the concrete surfaces. As an evaluation criterion, concrete chip sampling results will be directly compared to the closure performance standards for soil (Section H.3.7).

Concrete chip samples are collected at regularly-spaced intervals over an area. An initial location or time is chosen at random, and then the remaining sampling locations are defined so the locations are at regular intervals over an area (grid). The VSP software was used to create a systematic triangular grid layout with a random starting point. Sample locations were determined using a non-statistical sampling approach with a predetermined number of samples.

Professional judgment determined that nine chip samples would provide sufficient coverage to demonstrate successful decontamination (Figure H-7). Five grid node locations are identified for the concrete pad in front of the 277-T Building, and four are identified for the concrete pad at the back of the 277-T Building. Samples will be taken from the node locations indicated by the VSP software and will be assigned sample location identifications and sample numbers using the HEIS database. Supporting documentation for the VSP software sampling designations is provided in Attachment B, *T Plant 277-T Outdoor Storage Area Visual Sample Plan Supporting Documentation*.

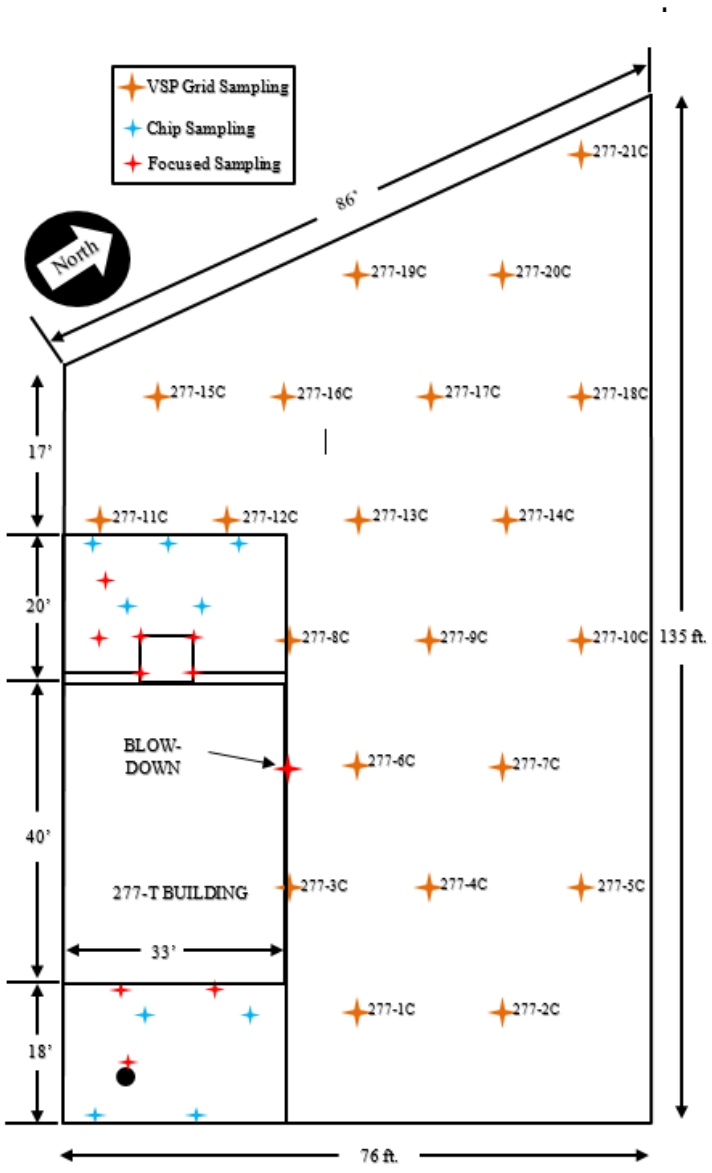

Figure H-7 277-T Outdoor Storage Area Sampling Locations

H.4.4.2 Sampling Methods and Handling

The grab sample matrix will consist of soil collected in clean sample containers. Soil will be collected at a depth of no more than 15 cm (6 in) below ground surface, unless staining or discoloration indicates contamination is below that depth. For the purpose of this SAP, ground surface is defined as the exposed soil surface layer once asphalt, concrete, or loose gravel has been removed. Once the soil is collected, the sampled media will be screened to remove material larger than approximately 2 mm (0.08 in) in diameter, which allows for a larger surface area-to-volume ratio. This ratio increases the likelihood of identifying any potential contamination in the sample.

Chip sampling is appropriate for porous surfaces (concrete) and will be accomplished with either a hammer and chisel, or an electric hammer. Sampling devices will be disposable, or either laboratory cleaned or field-decontaminated and kept wrapped until ready for use. Individuals will don appropriate personal protection equipment when breaking and/or sampling the concrete surface. An effort will be made to avoid scattering pieces out of the sampling boundary area. Any pieces that fall outside the sampling area will not be used. The area will be chipped to less than 0.25 in (approximately 0.64 cm), and preferably to 0.125 in (approximately 0.32 cm). Chipped pieces will be collected using a dedicated, decontaminated dustpan and natural bristle brush and transferred directly into the sampling bottle. Samples will be stored out of direct sunlight and cooled to ≤6°C, then delivered to the laboratory for analysis.

To ensure sample and data usability, sampling will be performed in accordance with established sampling practices, procedures, and requirements pertaining to sample collection, collection equipment, and sample handling. Sampling includes the following:

- Preparation and review of sampling paperwork such as COCs or labels.
- Sample container and equipment preparation.
- Field walk down of sample area (includes locating and marking sample locations and sample boundary areas).
- Sample collection.
- Sample packaging and shipping.

Sample preservation and holding time requirements are specified in Table H-6. These requirements are in accordance with the analytical method specified. The final container types and volumes will be identified on the sample authorization form and COC form.

Table H-6 Preservation, Container, and Holding Time Requirements for Soil and Concrete Samples

EPA Method	Analysis (Analytes)	Preservation Requirement	Holding Time	Bottle Type
6010	ICP-AES (Metals)	None	180 days	G/P
6020	ICP-MS (Metals)	None	180 days	G/P
7196	Colorimetric (Hexavalent Chromium)	Cool ≤6°C	30 days prior to extraction; 7 days after extraction	G/P
7471	Cold Vapor atomic absorption (Mercury)	Cool ≤6°C	28 days	G/P

Table H-6 Preservation, Container, and Holding Time Requirements for Soil and Concrete Samples

EPA Method	Analysis (Analytes)	Preservation Requirement	Holding Time	Bottle Type
8015	GC/Flame Ionization Detector (Non-halogenated Organics [Methanol])	Cool ≤6°C	14 days	G
8260	GC/MS (Volatile Organic Compounds)	Frozen*	14 days	G
8270	GC/MS (Semivolatile Organic Compounds)	Cool ≤6°C	14 days prior to extraction; 40 days after extraction	Amber Glass
9012	Colorimetric (Total Cyanide)	Cool ≤6°C	14 days from sampling to extraction; 40 days from extraction to analysis	G/P
9056	Ion Chromatography (Inorganic anions [Formic acid as Formate])	Cool ≤6°C	28 days	G/P

References: SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, Third Edition; Final Update V.

*Preservation techniques for soil samples collected include refrigeration immediately following collection (placing on ice) and freezing overnight prior to shipping. Holding times are from sampling to analysis unless specified otherwise.

AES = Atomic emission spectrometry
EPA = U.S. Environmental Protection Agency
GC = Gas chromatography
ICP = Inductively coupled plasma
MS = Mass spectrometry
G/P = Glass/plastic

A sampling and data-tracking database (e.g., HEIS) is used to track the samples from the point of collection through the laboratory analysis process. HEIS sample numbers are issued to the sampling organization for the project. Each sample is identified and labeled with a unique HEIS sample number.

To prevent potential contamination of the samples, clean equipment will be used for each sampling activity. Equipment used during sampling will be decontaminated or disposed of and managed as newly generated waste in accordance with Section H.3.6. Level I EPA pre-cleaned sample containers will be used for samples collected for chemical analysis. Container sizes may vary, depending on laboratory-specific volumes/requirements for meeting the PQL.

The date and time of sample collection, and the sample location, depth, and corresponding HEIS numbers will be documented in the sampler's field logbook. A custody seal (e.g., evidence tape) will be affixed to each sample container (except for Volatile Organic Analysis [VOA] sample containers) or the sample collection package in such a way as to indicate potential tampering. The custody seal will be inscribed with the sampler's initials and date. Custody tape is not applied directly to VOA sample containers based on the potential for affecting analyte results or fouling of laboratory equipment. Alternatively, VOA vials are placed in a sealable plastic bag affixed with custody seals and any other required labels/documentation.

Data verification and validation will also note any issues with sample collection and analysis. Each sample container will be labeled with the following information on firmly affixed, water-resistant labels:

- Sample authorization form and form number.
- HEIS number.
- Sample collection date and time.
- Sampler identification (e.g., initials).
- Analysis required.
- Preservation method (if applicable).
- COC identification number.

In addition to the container label information, sample records must include:

- Sample location.
- Matrix (e.g., soil).

Sample custody will be maintained in accordance with existing Hanford Facility protocols to ensure maintenance of sample integrity throughout the analytical process. COC protocols will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. A COC record is initiated in the field at the time of sampling and will accompany each set of samples shipped to any laboratory. At a minimum, the following information must be identified on a completed COC record:

- Collector(s) names.
- Project designation.
- Unique sample numbers.
- Date, time, and location (or traceable reference thereto) of sample collection.
- Chain of possession information (i.e., signatures/printed names of all individuals involved in the transfer of sample custody and storage locations, dates of receipt and relinquishment).

Additional information regarding the sample and specific analytical instructions may also be documented.

Discrepancies with the sample material (unusual color, texture, or odor), collection techniques, containers, or transfer packages are noted in the field logbook, communicated with the Project Manager, and corrective actions are initiated. For example, where a custody seal is damaged or missing, each case is individually reviewed for usability of the sample. The damaged or missing seal and action taken will be documented in the final data package. Data verification and validation will also note any issues with sample collection and analysis.

Contaminated environmental media and newly generated waste resulting from sampling activities will be handled in accordance with all applicable requirements of WAC 173-303-170 through WAC 173-303-230, as outlined in Sections H.3.5 and H.3.6.

H.4.4.3 Sampling and Analysis Requirements to Address Removal of Contaminated Soil, Asphalt and Concrete

The approach for resolving contamination identified during grid or focused sampling is described in the following subsections.

H.4.4.3.1 Resolving Contamination Identified During Grid (Area-Wide) Soil Sampling

In the event that grid (area-wide) sample results based on the MTCA (WAC 173-340) three-part test (Section H.4.4.1) indicate contamination above clean closure performance standards, then the contaminated soil from the node location(s) that indicated contamination, and any asphalt associated with the contamination, will be removed and managed in accordance with Section H.3.5 and Section H.3.6 respectively.

Following remediation of the contaminated soil and asphalt, VSP will be used to generate a new grid sampling design. The new grid sampling design will use a new random start point and new grid-node sampling locations, in accordance with the same model parameters established in Section H.4.4.1. Grab samples collected from the new grid-node locations will be analyzed for the constituents that previously did not meet closure performance standards. The new sample results will be analyzed to confirm clean closure as described in Section H.5.1. If the new sample results meet the closure performance standards, the asphalt and underlying soil will be considered clean. If the new sample results do not meet the closure performance standards, then the Permittees will meet with Ecology to determine a path forward for closure. Resulting changes to this closure plan will be submitted to Ecology as a permit modification request in accordance with Permit Condition I.C.3.

The new grid sampling design, analytical results, and corresponding VSP report documentation will be provided as supporting information with the closure certification as described in Section H.5.3.

H.4.4.3.2 Resolving Contamination Identified During Focused Soil Sampling and Grid (Non-Statistical) Concrete Chip Sampling

If focused soil or concrete chip sample results based on direct comparison (Section H.4.4.1) indicate contamination above closure performance standards, then sample location(s) will be remediated to remove contaminated soil or concrete. Following remediation, confirmatory sampling will be performed in accordance with this closure SAP. Analytical results of confirmatory sample(s) collected at focused and chip sample location(s) will be directly compared to the closure performance standards to confirm remediation efforts were effective and the area is clean. If after remediation the soil or concrete does not meet closure performance standards, then the Permittees will meet with Ecology to determine a path forward for closure. Resulting changes to this closure plan will be submitted to Ecology as a permit modification request in accordance with Permit Condition I.C.3.

H.4.4.4 Analytical Methods

All analyses and testing will be performed consistent with this closure plan, laboratory contracts, and laboratory analytical procedures at the time of closure. The contracted analytical laboratory must achieve the lowest PQLs consistent with the selected analytical method (identified in Table H-4) in order to confirm that the closure performance standards are met.

H.4.4.5 Quality Control

QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and provide information pertinent to field sampling variability. Field QC samples include the collection of:

- Field trip blanks.
- Field transfer blanks.
- Equipment rinsate blanks.
- Field duplicates.

Laboratory QC samples estimate the precision and bias of the analytical data. Laboratory QC samples include:

- Method blanks.
- Laboratory duplicates.
- Matrix spikes.
- Matrix spike duplicates.
- Surrogates.
- Laboratory control samples.

Field and laboratory QC samples are summarized in Table H-7.

Table H-7 Project Quality Control Sampling Summary

QC Sample Type	Frequency	Characteristics Evaluated
Field QC		
Field Trip Blanks	One per 20 samples, minimum of one per decision unit	Field trip blanks are used to assess contamination from sample containers or during transportation and storage procedures.
Field Transfer Blanks	One per day that volatile organic compounds are sampled	Field transfer blanks are used to assess contamination from surrounding sources during sample collection.
Equipment Rinsate Blanks	One per 20 samples per analytical method	Equipment rinsate blanks are used to measure the cleanliness of sampling equipment and effectiveness of equipment decontamination procedures. Equipment rinsate blanks are not required if only disposable equipment is used, or if rinsing between samples is not practical (e.g., core drilling equipment).
Field Duplicates	One per 20 samples with a minimum of one per decision unit	Field duplicates are used to assess the precision of the entire data collection activity, including sampling, analysis, and site heterogeneity.
Laboratory QC*		
Method Blanks	One per batch	Method blanks measure contamination associated with laboratory sample preparation and analysis.
Laboratory Duplicates	One per laboratory analytical batch	Laboratory duplicates measure laboratory reproducibility and precision.
Matrix Spikes	One per laboratory analytical batch	The matrix spike recovery measures the effects of interferences in the sample matrix and reflects the accuracy of the determination.
Matrix Spike Duplicates	One per laboratory analytical batch	The relative percent difference between matrix spikes and matrix spike duplicates measures the precision of a given analysis.
Surrogates	Added to each sample and QC (laboratory and field) sample	Surrogate standards are added prior to extraction of the sample to evaluate accuracy, method performance, and extraction efficiency.

Table H-7 Project Quality Control Sampling Summary

QC Sample Type	Frequency	Characteristics Evaluated
Laboratory Control Samples	One per laboratory analytical batch	The laboratory control samples measure the accuracy of the analytical methods.

*Batching across projects is allowed for similar matrices.

H.4.5 Data Review, Verification, Validation, and Usability Requirements

Analytical results will be received from the contract analytical laboratory, loaded into a database (e.g., HEIS), and verified in accordance with Section H.4.5.1. A total of 5% of the data will be validated as described in Section H.4.5.2. Grid (area-wide) soil sample results will be evaluated to ensure VSP model assumptions were correct (Section H.4.5.3) and a data quality assessment (DQA) will be conducted to ensure the output of the DQO process provided appropriate values (Section H.4.5.4).

H.4.5.1 Data Verification

Verification activities ensure analytical data in the database were properly uploaded and reflect the contract laboratory program equivalent data packages. The steps outlined below will consider both the primary and QC samples. Activities will include, but are not limited to, the following:

- Amount of data requested matches the amount of data received (number of samples for requested methods of analytes).
- Correct procedures/methods are used.
- Issues with sample collection and analysis are noted.
- Documentation/deliverables are complete.
- Hard copy and electronic versions of the data are identical.
- Data is reasonable based on analytical methodologies.

H.4.5.2 Data Validation

The contract analytical laboratory supplies the equivalent of contract laboratory program analytical data packages intended to support data validation by the third party. These data packages are supported by QC test results and raw data. Data validation includes both primary and QC samples, and considers issues with sample collection and analysis.

Controls are in place to preserve the data sent to the validators, such as allowing only additions to be made, not changes to the raw data. The format and requirements for data validation activities are based on the most current version of EPA-540-R-08-01, *National Functional Guidelines for Superfund Organic Methods Data Review* (OSWER 9240.1-48), and EPA-540-R-10-011, *National Functional Guidelines for Inorganic Superfund Data Review* (OSWER 9240.1-51). As defined by the validation guidelines, 5% of the analytical results will undergo Level C validation.

H.4.5.3 Verification of Visual Sample Plan (VSP) Input Parameters

Analytical data from grid (area-wide) soil sampling will be entered back into the VSP data analysis function to generate the data Analysis Report. If all analytical data for a particular analyte are nondetectable at levels below the closure performance standard, then verification of VSP input parameters is not required for that analyte. VSP software uses the analytical data to determine if the user input parameters were estimated appropriately.

Once analytical data are entered into VSP, the software will calculate the true standard deviation and determine if the null hypothesis can be rejected (Section H.4.4.1). If the calculated standard deviation is smaller than the estimated user input standard deviation, then no additional sampling will be required. If the calculated standard deviation is larger than the estimated standard deviation, then additional sampling may be required.

Verification of the null hypothesis through VSP will determine if the mean value of the site analytical data supports rejection of the null hypothesis (Section H.4.4.1). If additional statistical tools are identified, such as EPA's ProUCL[2], then they will be used, as appropriate, to augment evaluation of the data set.

H.4.5.4 Data Quality Assessment

A DQA will be performed on the final data using the guidance in EPA/240/B-06/002, *Data Quality Assessment: A Reviewer's Guide* (EPA QA/G-9R), and implementing the specific requirements in Sections H.4.5.1 through H.4.5.3.

H.4.6 Revisions to the Sampling and Analysis Plan and Constituents to be Analyzed

Changes to the SAP may be necessary due to unexpected events during closure. An unexpected event would be an event outside the scope of the SAP or a condition that inhibits implementation of the SAP as written. Revisions to the SAP will be submitted no later than 30 days after the unexpected event as a permit modification request. [WAC 173-303-610(3)(b)]

H.5 Confirmation and Certification of Closure Activities

Confirmation of closure will be performed using methods defined in Section H.5.1. Closure certification is performed by an Independent Qualified Registered Professional Engineer (IQRPE) (Section H.5.2). Certification will be submitted to Ecology as described in Section H.5.3, and the conditions of the DWMU after closure are described in Section H.3.11. The timing of closure is described in Section H.6.

H.5.1 Confirmation of Clean Closure

The 277-T Outdoor Storage Area will be clean closed through confirmation of successful decontamination determined by chip sampling of the concrete surfaces, and through sampling of soil beneath the asphalt and concrete.

H.5.1.1 Confirmation of Site-Specific Decontamination

On completion of decontamination activities at the concrete surfaces, those areas will be chip sampled to confirm whether decontamination was successful.

The following is identified in Ecology Guidance Publication # 94-111.

Section 5.3.2 Site-Specific Decontamination Methods

> At a minimum, requests for approval of site-specific decontamination methods must include:
>
> - Information demonstrating that the proposed decontamination method is in compliance with the closure performance standard at WAC 173-303-610(2), including information demonstrating that the proposed decontamination method or standard will control, minimize, or eliminate post-closure escape of dangerous waste, dangerous constituents, leachate, contaminated run-off, and dangerous waste decomposition products to the ground, surface water, ground water, and air.

[2]ProUCL Software is a comprehensive statistical software package developed and maintained by EPA.

- Information demonstrating that the proposed decontamination method is in compliance with federal, state, and local requirements.
- Information demonstrating that the proposed decontamination method is protective of human health and the environment.
- Proposed evaluation criteria to measure the effectiveness of the site-specific decontamination method. For example, MTCA unrestricted site use cleanup levels might be used to define when debris is considered decontaminated.

Section 5.6.1. Decontamination Options for Concrete

> …in some cases, decontamination of concrete using high-pressure steam or water washing, with appropriate site-specific performance standards, may be a better option than removal of the top 0.6 cm of concrete surface. If high-pressure stem or water washing is used, the site-specific decontamination performance standard might involve comparing concrete chip samples with MTCA unrestricted site use cleanup levels.

This confirmatory step will be documented. Documentation will include photos, dimensions (depth and area), and locations of chip sampling. Chip sample results from the contract analytical laboratory will be reviewed to confirm that target analytes have met closure performance standards (Table H-4). Once it has been determined that analytical results from chip sampling are below the closure performance standards, the concrete pad structures in the 277-T Outdoor Storage Area DWMU will be considered clean.

H.5.1.2 Confirmation of Soil Sample Results

Soil sample results from the contract analytical laboratory will be reviewed to confirm that target analytes have met closure performance standards (Table H-4). Once it has been determined that soil sample results have met closure performance standards, then the soil beneath the 277-T Outdoor Storage Area concrete pads and asphalt will be considered clean.

Once clean closure has been confirmed for the 277-T Outdoor Storage Area DWMU, a closure certification will be prepared in accordance with Section H.5.3.

H.5.2 Role of the Independent Qualified Registered Professional Engineer

An IQRPE will be retained to provide certification of the closure as required by WAC 173-303-610(6). The IQRPE will be responsible for observing field activities and reviewing documents associated with clean closure of the 277-T Outdoor Storage Area DWMU. At a minimum, the following field activities will be completed:

- Review 277-T Outdoor Storage Area visual inspection documentation.
- Observe and/or review decontamination of concrete surfaces.
- Verify that locations of chip and soil samples are as specified in the SAP.
- Observe and/or review concrete chip and soil sampling activities.
- Review sampling procedures and results.
- Observe and/or review contaminated environmental debris removal (as applicable).
- Observe and/or review newly generated waste management and disposition records.
- Verify that closure activities were performed in accordance with this closure plan.

The IQRPE will record observations and reviews in a written report that will be retained in the operating record. The resulting report will be used to develop the clean closure certification, which will then be submitted to Ecology.

H.5.3 Closure Certification

Within 60 days of completion of closure of the 277-T Outdoor Storage Area DWMU, a certification that the DWMU has been closed in accordance with the specifications in this closure plan will be submitted to Ecology by registered mail or other means that establish proof of receipt (including applicable electronic means). The certification will be signed by the Permittees and by the IQRPE.

At the time of the closure certification submittal, the Permittees will submit to Ecology information to support the closure certification. [WAC 173-303-610(6)]

This supporting information will include at least the following:

- All field notes and photographs related to closure activities.
- A description of any minor deviations from this closure plan and justification for the deviations.
- Documentation of the removal and final disposition of any unanticipated contaminated environmental media.
- Documentation of the removal and final disposition of any newly generated waste.
- All laboratory and/or field data, including sampling procedures, sampling locations, QA/QC samples, and COC procedures for all samples and measurements, including samples and measurements taken to determine background conditions and determine or confirm clean closure.
- A summary report that identifies and describes the data reviewed by the IQRPE and tabulation of the analytical results of samples taken to determine and confirm clean closure performance standards were met.
- Description of the 277-T Outdoor Storage Area DWMU appearance at completion of closure, including what parts of the former unit, if any, will remain after closure.

H.6 Closure Schedule and Time Frame

Closure activities will be completed no more than 180 days after the effective date of the approved permit modification incorporating this closure plan. [WAC 173-303-610(4)(b)]

Should an unexpected event occur and an extension to the 180-day closure activity expiration date be deemed necessary, a permit modification request will be submitted to for approval at least 30 days prior to expiration of the 180 days. [WAC 173-303-610(4)(c)]

The Permit modification request will include the statement that closure activities will of necessity, take longer than 180 days to complete, and the supporting basis for the statement. The permit modification request will also include necessary information demonstrating that all steps to prevent threats to HHE have been and will continue to be taken, including compliance with all applicable permit requirements. [WAC 173-303-610(4)(b)]

The closure certification will be submitted to Ecology within 60 days following completion of closure activities at the 277-T Outdoor Storage Area DWMU (Table H-8 and Figure H-8).

Table H-8 277-T Outdoor Storage Area Dangerous Waste Management Unit Closure Schedule

Activity	Description	Duration
Closure Activities		
Remove All Waste	Package and ship dangerous and mixed waste to a RCRA permitted facility for treatment, storage, or disposal.	Completed (Section H.3.1)
Records Review	Perform review of 277-T Outdoor Storage Area container storage, operating, and inspection records.	Completed (Section H.3.2)
Perform Visual Inspection 277-T Outdoor Storage Area	Inspect concrete surface for dangerous or mixed waste related staining.	Completed (Section H.3.2)
	Inspect for visible holes, cracks, crevices, pits, joints/seams, or other breaches in structural integrity. Identify focused sampling locations (as applicable).	
Address Concrete Pads	Decontaminate 277-T Outdoor Storage Area concrete pad surfaces (Section H.3.4).	70 Days
	Perform concrete chip sampling and analysis in accordance with the SAP (Section H.4).	
	Perform data verification/validation and data quality assessment (Section H.4.5).	
	If necessary, remove contaminated concrete, resample, and analyze (Section H.4.4.3).	
Address Soil Beneath Concrete Pads and at Blow-Down Drain	Perform focused sampling and analysis in accordance with SAP (Section H.4).	40 Days
	Perform data verification/validation and data quality assessment (Section H.4.5).	
	If necessary, remove contaminated environmental media, resample, and analyze (Section H.4.4.3).	
Address Soil Beneath Asphalt	Perform grid (area-wide) sampling and analysis in accordance with SAP (Sections H.4.4).	60 Days
	Perform data verification and validation of VSP input parameters, and data quality assessment, as applicable (Section H.4.5).	
	If necessary, remove contaminated environmental media, resample, and analyze (Section H.4.4.3).	
Confirm Clean Closure	Review sample results from contract analytical laboratory. Ensure closure performance standards were met (Section H.5.1).	10 Days
Closure Certification		
Permittees and IQRPE Submit Closure Certification	Within 60 days of completion of closure activities, submit certification to Ecology that the DWMU has been closed in accordance with the specifications in this closure plan (Section H.5.3).	60 Days

Reference: WAC 173-303-610, Dangerous waste regulations, *Closure and post-closure*.

1

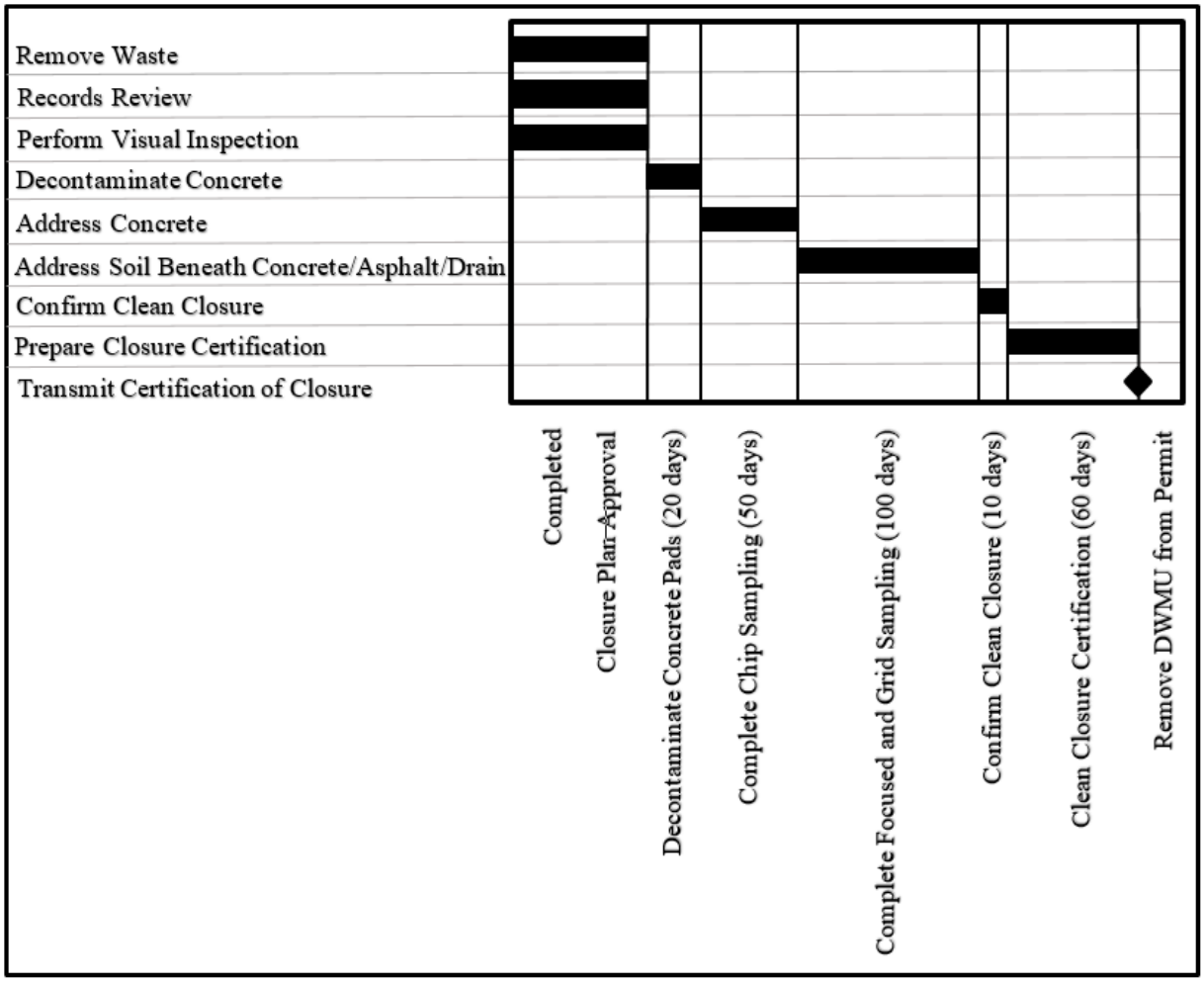

Figure H-8 277-T Outdoor Storage Area Closure Schedule activities

H.7 Closure Costs

An annual report outlining updated projections of anticipated closure costs for the Hanford Facility treatment, storage, and disposal units is not required per Permit Condition II.H.

H.8 References

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173-340-900, *Tables.*

ATTACHMENT A
T PLANT 277-T OUTDOOR STORAGE AREA
VISUAL INSPECTION SUPPORTING DOCUMENTATION

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T Plant Complex 277-T Outdoor Container Storage Area

Purpose:

A visual inspection walkdown of the T Plant Complex 277-T Outdoor Container Storage Area was performed to determine if there is any evidence of spills and/or leaks from waste packages containing dangerous waste that was stored at this location from ongoing and past operations. The inspection was to identify and document by photographing any waste related staining of the storage area surface (i.e., asphalt and concrete), and to denote any remaining waste related items.

The inspection was performed on August 29, 2013 by Brett M. Barnes (CHPRC) Environmental Compliance Officer.

Results:

Stains from rusting equipment was observed on the concrete pad and the asphalt pad (see attached photographs). Area was thoroughly photographed.

Some items were observed in the 277-T Outdoor Container Storage Area:

- Metal posts
- Wire roping and radiological postings
- White road paint for striping
- ERDF roll-off/roll-on box (actively used for accumulation of low-level waste)
- Pieces of tumbleweeds
- Loose gravel

Housekeeping will be performed on the area prior to closure.

Signature/Date:

Brett M. Barnes: Brett M Barnes 9/3/13

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Strickling, Lana R

From:	Barnes, Brett M
Sent:	Tuesday, September 03, 2013 1:34 PM
To:	Horn, Sarah R; Strickling, Lana R
Cc:	Engelmann, Richard H; Dixon, Brian J; Ruck, Fred A III; Seaver, Jennie R
Subject:	REVISED T PLANT COMPLEX 277-T OUTDOOR CONTAINER STORAGE AREA CLOSURE INSPECTION REPORT
Attachments:	SPDQ0638013090313013.pdf

All, please ignore my previous closure inspection reports...I had to correct some editorial comments.

Attached is the closure inspection report for the T Plant Complex 277-T Outdoor Container Storage Area. The photographs that are attached to this report are directly below, in descending order. Should you have any questions, please call me on my cell phone, 521-3053.

Brett M. Barnes
Environmental Compliance Officer

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2

T Plant Complex 277-T Building Storage Area

Purpose:

A visual inspection of the T Plant Complex 277-T Outdoor Storage Area was performed to identify low points, seams, cracks, crevices, and drains for the purpose of focused sampling during closure. If a random sample determined through the use of the Visual Sampling Plan software was already identified in the vicinity of a low point, crack, crevice, sump or drain, additional focused samples were not deemed necessary.

The inspection was performed on June 01, 2015.

Results:

As a result of the inspection, three focused sample locations were identified. Identified were two seam samples and one condensate blow-down line drain sample. These sample locations along with the current VSP random samples are identified in the below figure which will be included in the 277-T Outdoor Storage Area closure plan.

Signature/Date:

Sarah Horn 7/28/2015

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ATTACHMENT B
T PLANT 277-T OUTDOOR STORAGE AREA
VISUAL SAMPLE PLAN SUPPORTING DOCUMENTATION

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.

Predetermined Number of Systematic Sampling Locations

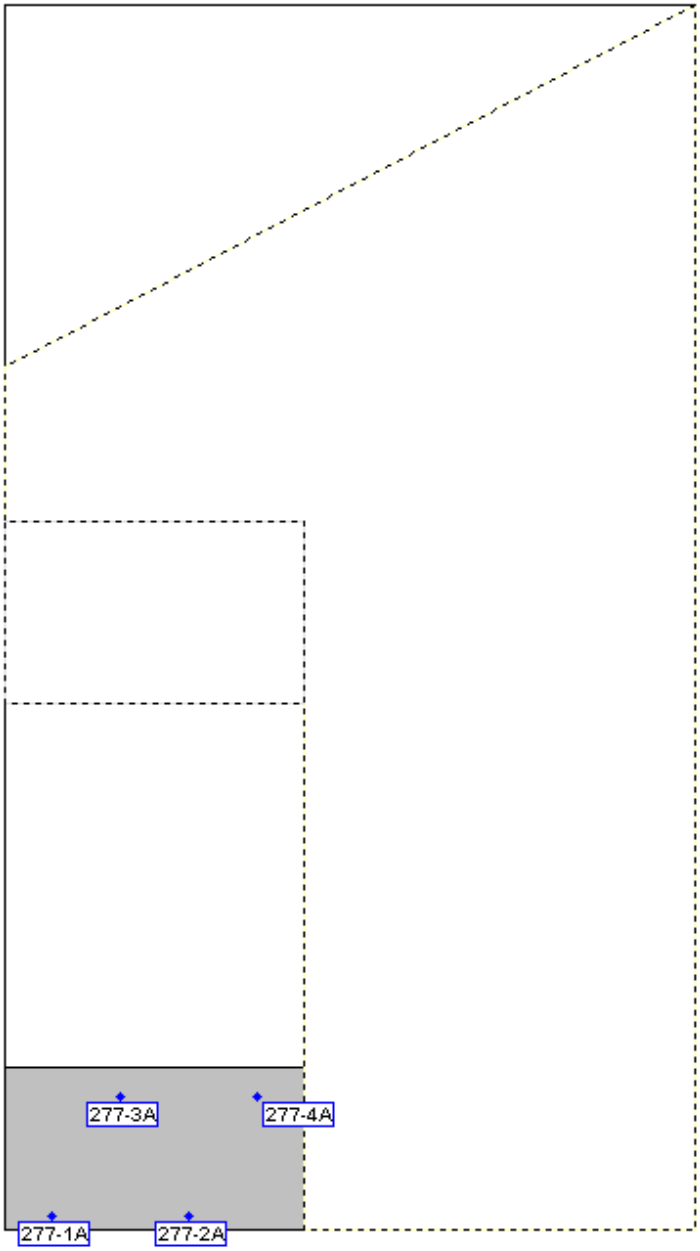
Summary

This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design. A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Direct Comparison of chip sample results to numeric closure performance standards
Sample Placement (Location) in the Field	Systematic with a random start location
User specified number of samples	4
Number of samples on map [a]	4
Number of selected sample areas [b]	1
Specified sampling area [c]	594.00 ft^2
Size of grid/Area of grid cell [d]	15.1205 feet / 198 ft^2
Grid pattern	Triangular

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Size of grid/Area of grid cell gives the linear and square dimensions of the grid used to systematically place samples.



(0, 0) South Corner
(-119.61807, 46.56205)

Area: Area A						
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**	**Sample Area**
5.1088	1.6053	277-1A		Systematic		
20.2294	1.6053	277-2A		Systematic		
12.6691	14.7001	277-3A		Systematic		
27.7896	14.7001	277-4A		Systematic		

Primary Sampling Objective

The primary purpose of sampling at this site is unknown to Visual Sample Plan. The number of samples may have been calculated in another sampling design in Visual Sample Plan, or may have been calculated externally to VSP. Alternatively, the purpose may be based entirely on professional judgment.

Selected Sampling Approach

This sampling approach is to determine if decontamination is successful. Systematic non-statistical sampling was created with a pre-determined number of samples based on professional judgement. Locating the sample points over a systematic grid with a random start ensures spatial coverage of the site and eliminates bias when selecting sampling locations. Locating the sample points systematically provides data that are all equidistant apart and ensures that all portions of the site are equally represented.

Predetermined Number of Systematic Sampling Locations

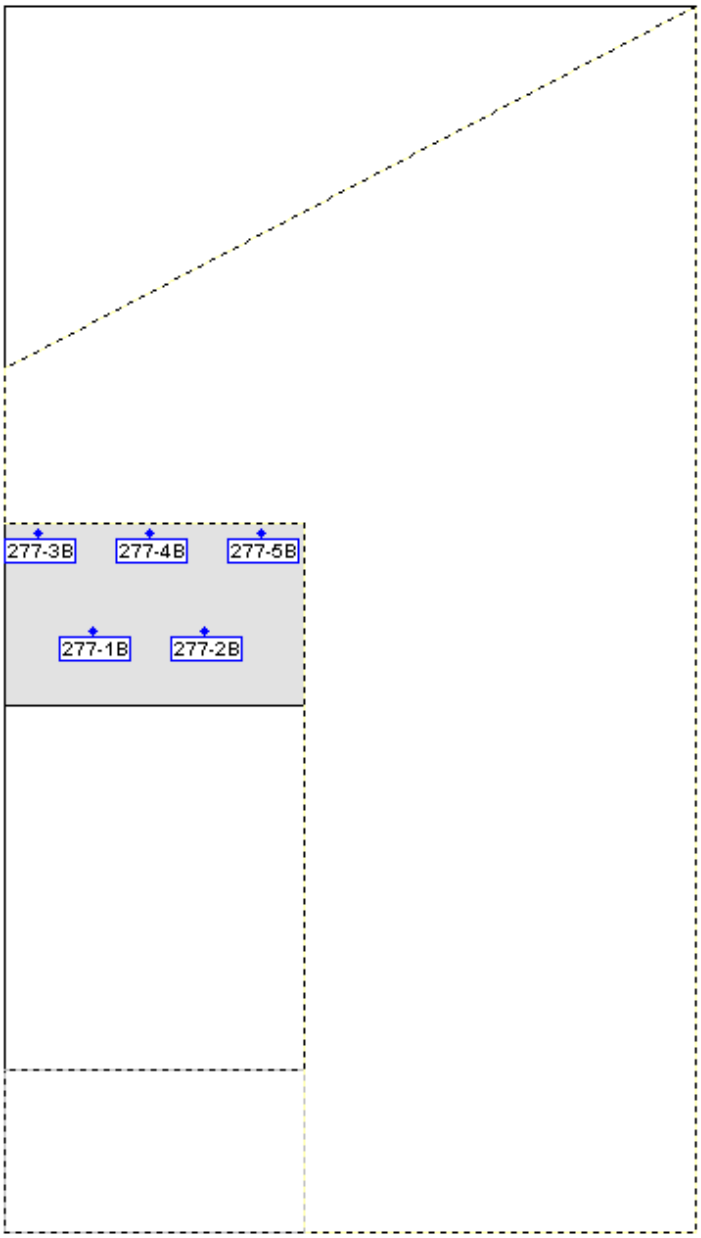
Summary

This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design. A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Direct Comparison of chip sample results to numeric closure performance standards
Sample Placement (Location) in the Field	Systematic with a random start location
User specified number of samples	5
Number of samples on map [a]	5
Number of selected sample areas [b]	1
Specified sampling area [c]	660.00 ft^2
Size of grid / Area of grid cell [d]	12.3459 feet / 132 ft^2
Grid pattern	Triangular

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Size of grid / Area of grid cell gives the linear and square dimensions of the grid used to systematically place samples.



Area: Area B						
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**	**Sample Area**
9.6913	66.2494	277-1B		Systematic		
22.0372	66.2494	277-2B		Systematic		
3.5184	76.9412	277-3B		Systematic		
15.8643	76.9412	277-4B		Systematic		
28.2101	76.9412	277-5B		Systematic		

Primary Sampling Objective

The primary purpose of sampling at this site is unknown to Visual Sample Plan. The number of samples may have been calculated in another sampling design in Visual Sample Plan, or may have been calculated externally to VSP. Alternatively, the purpose may be based entirely on professional judgment.

Selected Sampling Approach

This sampling approach is to determine if decontamination was successful. Systematic non-statistical sampling was created with a pre-determined number of samples based on professional judgement. Locating the sample points over a systematic grid with a random start ensures spatial coverage of the site and eliminates bias when selecting sampling locations. Locating the sample points systematically provides data that are all equidistant apart and ensures that all portions of the site are equally represented.

Systematic sampling locations for comparing a median with a fixed threshold (nonparametric – MARSSIM)

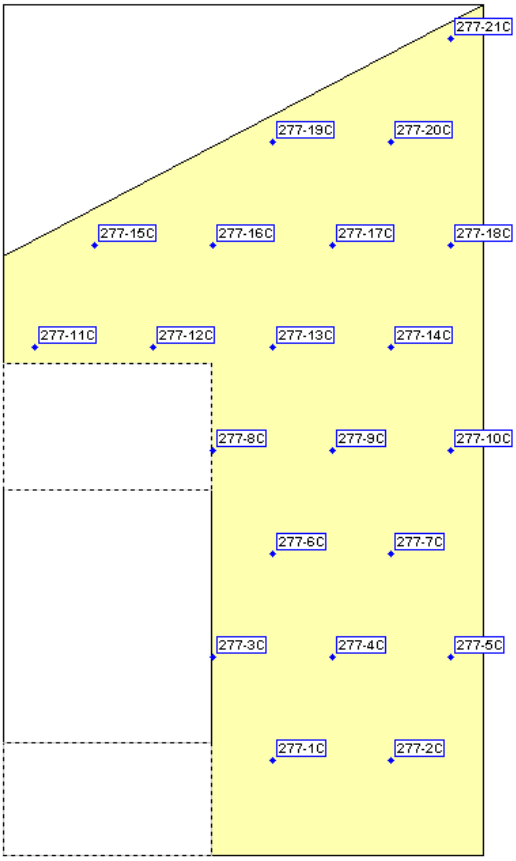
Summary

This report summarizes the sampling design, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design. A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean or median to a fixed threshold
Type of Sampling Design	Nonparametric
Sample Placement (Location) in the Field	Systematic with a random start location
Working (Null) Hypothesis	The median(mean) value at the site exceeds the threshold
Formula for calculating number of sampling locations	Sign Test – MARSSIM version
Calculated number of samples	16
Number of samples adjusted for EMC	16
Number of samples with MARSSIM Overage	20
Number of samples on map [a]	21
Number of selected sample areas [b]	1
Specified sampling area [c]	6163.20 ft^2
Size of grid / Area of grid cell [d]	18.8635 feet / 308.16 ft^2
Grid pattern	Triangular

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Size of grid / Area of grid cell gives the linear and square dimensions of the grid used to systematically place samples.



Area: Area C						
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**	**Sample Area**
42.5952	15.1941	277-1C		Systematic		
61.4587	15.1941	277-2C		Systematic		
33.1635	31.5304	277-3C		Systematic		
52.0270	31.5304	277-4C		Systematic		
70.8905	31.5304	277-5C		Systematic		
42.5952	47.8666	277-6C		Systematic		
61.4587	47.8666	277-7C		Systematic		
33.1635	64.2029	277-8C		Systematic		
52.0270	64.2029	277-9C		Systematic		
70.8905	64.2029	277-10C		Systematic		
4.8682	80.5392	277-11C		Systematic		
23.7317	80.5392	277-12C		Systematic		
42.5952	80.5392	277-13C		Systematic		
61.4587	80.5392	277-14C		Systematic		
14.2999	96.8755	277-15C		Systematic		
33.1635	96.8755	277-16C		Systematic		
52.0270	96.8755	277-17C		Systematic		
70.8905	96.8755	277-18C		Systematic		
42.5952	113.2118	277-19C		Systematic		
j	113.2118	277-20C		Systematic		
70.8905	129.5481	277-21C		Systematic		

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a site median or mean value with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the median(mean) value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the median(mean) value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative one, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A nonparametric systematic sampling approach with a random start was used to determine the number of samples and to specify sampling locations. A nonparametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that typical parametric assumptions may not be true.

Both parametric and non-parametric equations rely on assumptions about the population. Typically, however, non-parametric equations require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than if a non-parametric equation was used.

VSP offers many options to determine the locations at which measurements are made or samples are collected and subsequently measured. For this design, systematic grid point sampling was chosen. Locating the sample points systematically provides data that are all equidistant apart. This approach does not provide as much information about the spatial structure of the potential contamination as simple random sampling does. Knowledge of the spatial structure is useful for geostatistical analysis. However, it ensures that all portions of the site are equally represented. Statistical analyses of systematically collected data are valid if a random start to the grid is used.

Nuclides
The following table summarizes the analyzed nuclides.

Nuclides Analyzed by Study		
Nuclide	**$DCGL_W$**	**$DCGL_{EMC}$**
Analyte 1	1	

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Sign test (see PNNL 13450 for discussion). For this site, the null hypothesis is rejected in favor of the alternative one if the median(mean) is sufficiently smaller than the threshold. The number of samples to collect is calculated so that if the inputs to the equation are true, the calculated number of samples will cause the null hypothesis to be rejected.

The formula used to calculate the number of samples is:

$$n = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4(SignP - 0.5)^2}$$

where

$$SignP = \Phi\left(\frac{\Delta}{s_{total}}\right)$$

$\Phi(z)$ is the cumulative standard normal distribution on $(-\infty,z)$ (see PNNL-13450 for details),
n is the number of samples,
S_{total} is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site median(mean) is less than the threshold,
β is the acceptable probability of incorrectly concluding the site median(mean) exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

Note: MARSSIM suggests that the number of samples should be increased by at least 20% to account for missing or unusable data and uncertainty in the calculated value of n. VSP allows a user-supplied percent overage as discussed in MARSSIM (EPA 2000, p. 5-33).

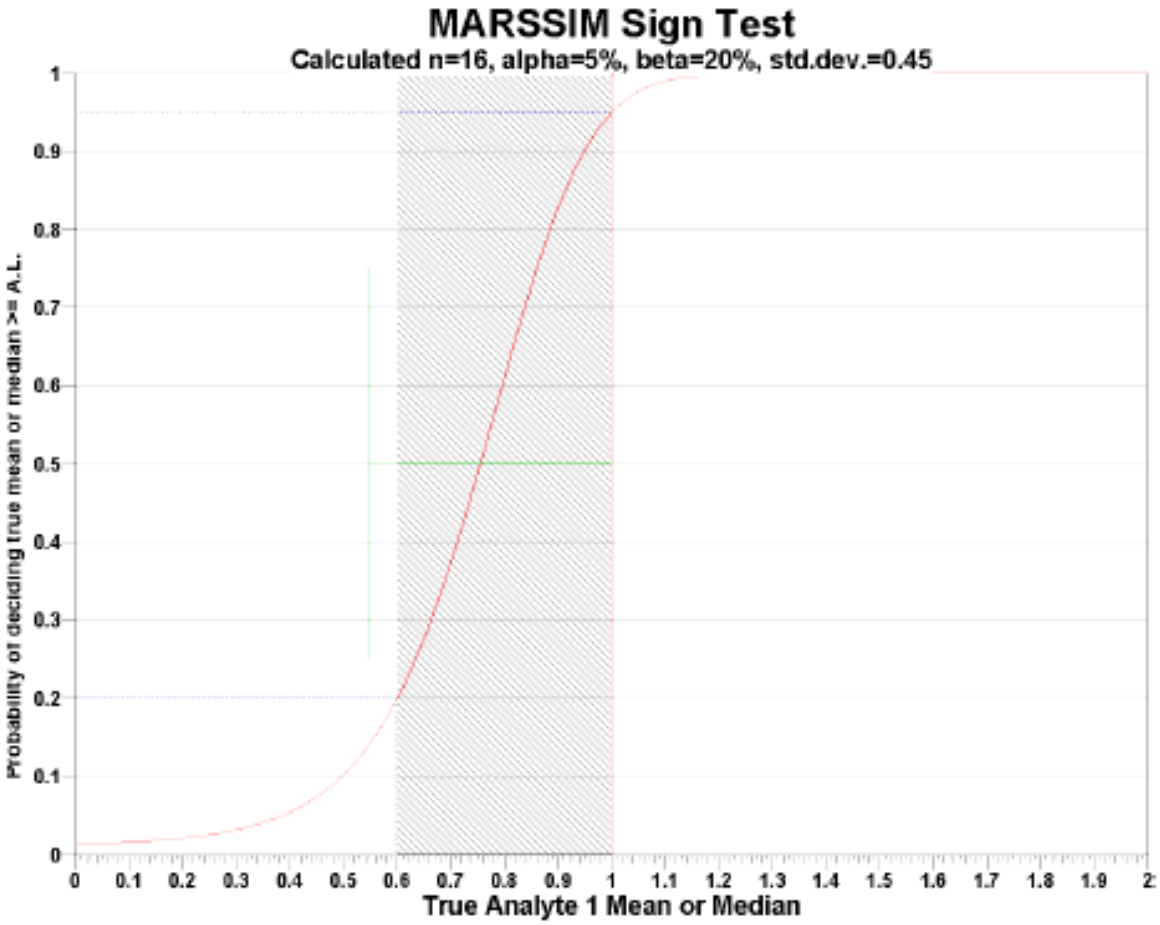
For each nuclide in the **Nuclides Analyzed by Study** table, the values of these inputs that result in the calculated number of sampling locations are:

Nuclide	n[a]	n[b]	n[c]	Parameter					
				S	Δ	α	β	$Z_{1-\alpha}$ [d]	$Z_{1-\beta}$ [e]
Analyte 1	16	16	20	0.45	0.4	0.05	0.2	1.64485	0.841621

[a] The number of samples calculated by the formula.
[b] The number of samples increased by EMC calculations.
[c] The final number of samples increased by the MARSSIM Overage of 20%.
[d] This value is automatically calculated by VSP based upon the user defined value of α.
[e] This value is automatically calculated by VSP based upon the user defined value of β.

Performance
The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000). It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true median(mean) values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at $1-\alpha$ on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at $1-\alpha$. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the computed sign test statistic is normally distributed,
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected probabilistically.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the gridded sample locations were selected based on a random start.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that $\mu >$ action level and alpha (%), probability of mistakenly concluding that $\mu <$ action level. The following table shows the results of this analysis.

Number of Samples							
AL=1		α=5		α=10		α=15	
		s=0.9	s=0.45	s=0.9	s=0.45	s=0.9	s=0.45
LBGR=90	β=15	1103	280	825	209	659	167
	β=20	948	240	692	176	542	138
	β=25	826	209	587	149	449	114
LBGR=80	β=15	280	75	209	56	167	45
	β=20	240	64	176	47	138	36
	β=25	209	56	149	40	114	30
LBGR=70	β=15	128	36	95	27	77	22
	β=20	110	32	81	23	63	18
	β=25	95	27	69	20	52	15

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Note: values in table are note adjusted for EMC